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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

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THE AMERICAN PHYSICAL SOCIETY

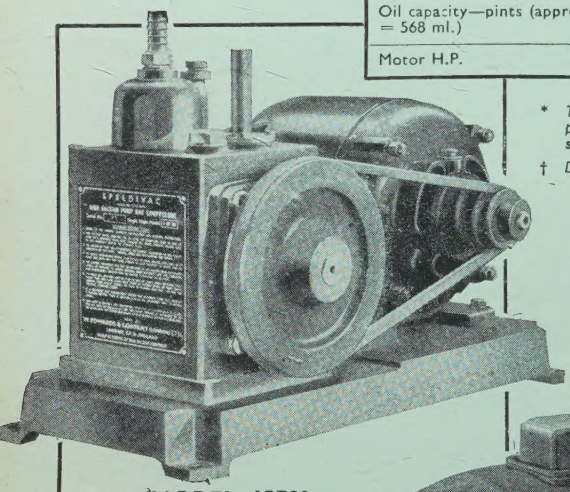
THE AMERICAN
INSTITUTE OF ELECTRICAL ENGINEERS

ABSTRACTS 1-778

VOLUME 54 **JANUARY 1951** NUMBER 637

The "Big Brother" of th
'SPEEDIVAC' (Regd.) Famil

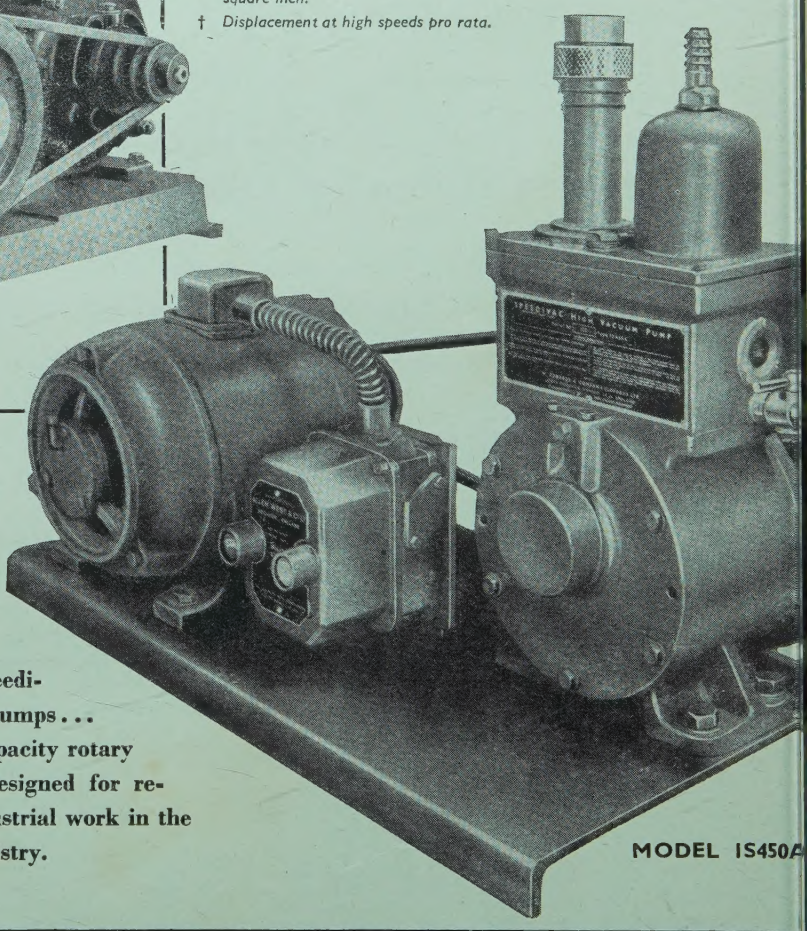
	SINGLE-STAGE				TWO-STAGE		
	1SP30*	1S50	1S150	**1S450A**	2S20	2S50	
Ultimate vacuum-mm. Hg. (McLeod gauge)	0·02	0·005	0·005	**0·005**	0·0001	0·00005	0
Normal running speed—r.p.m.	700	450	450	**350**	450	450	
Alternative speed—r.p.m.	450	700	700				
Free air displacement—litres/min. at normal speed†	32	48	144	**450**	22	48	
Oil capacity—pints (approx.) (1 pint = 568 ml.)	1	1½	2¾	**3**	1	2¾	
Motor H.P.	⅛	¼	⅓	**1½**	⅛	⅓	



MODEL ISP30
(SEE TABLE ABOVE)

* *This pump can also be used as a compressor for pressure up to 10 lb. per square inch.*

† *Displacement at high speeds pro rata.*



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Principal Contents

JANUARY 1951

		PAGE
51	MATHEMATICS	1
52	ASTRONOMY. ASTRO-PHYSICS. GEODESY	3
53	PHYSICS	8
530.1	Fundamentals	8
531	General mechanics. Mechanics of solids	12
531.7	Mechanical measurements	13
532	Mechanics of fluids	13
532.6	Capillarity	14
532.7	Molecular theory of liquids	14
533	Mechanics of gases	15
533.7	Molecular theory of gases	—
534	Vibrations. Acoustics	18
535	Optics. Radiation. Spectra	21
536	Heat	30
536.7/.8	Thermodynamics	32
537	Electricity	—
537.1	Theory. Electrons	—
537.2	Electrostatics. Dielectrics	34
537.3	Electric conduction. Currents	36
537.52	Electric discharges	40
537.531	X-rays	42
537.533/.534	Cathode rays. Positive rays	43
537.54	Discharge tubes. Counters	45
537.56/.58	Ionization. Thermionics	46
537.591	Cosmic rays	47
538	Magnetism	55
538.3/.5	Electromagnetism. Electrodynamics	58
538.56	Electromagnetic waves and oscillators	58
538.6	Magnetic effects	59
539.1	Molecular and atomic structure	—
539.11	Theory of solid state	—
539.13	Molecular structure	60
539.15	Atomic structure. Nucleus. Isotopes	61
539.16	Radioactivity. α-, β- and γ-rays	64
539.17	Nuclear reactions	67
539.18	Atom and molecule beams. Mesons. Neutrons	71
539.2	Structure of solids	73
539.3/.8	Elasticity. Strength. Rheology	75
541	PHYSICAL CHEMISTRY	78
541.11/.12	Phase equilibrium. Chemical reactions	78
541.13	Electrochemistry	78
541.14	Photochemistry. Radiation chemistry	79
541.18	Dispersions. Colloids. Adsorption	80
541.4/.6	Chemical structure	81
542.1/.7	Laboratory apparatus	—
543/545	Chemical analysis	82
548	CRYSTALLOGRAPHY	82
548.7	Molecular and X-ray crystallography	84
55	GEOPHYSICS	85
551.5	Atmosphere. Meteorology	85
57/59	BIOLOGY	87
61	Medical science. Human physiology	87
66/67	TECHNICAL MATERIALS	88
77	PHOTOGRAPHY	88

RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Mechanical testing
Non-destructive testing
Industrial radiography
Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplement published with the Index to Volume 53 (1950). Reprints of the List of Journals (1950) and the Supplement (1950) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2*s.* post free.

The addresses given are believed to be correct at the date of publication, but nó responsibility can be accepted for errors.

Journals marked * are not received regularly.

Aust. J. Appl. Sci.	*Australian Journal of Applied Science.* Commonwealth Scientific and Industrial Research Organization, 314 Albert Street, East Melbourne, C.2.
**C.R. Rech. I.R.S.I.A.*	*Comptes Rendus de l'Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture.* 52 Rue de la Concorde, Brussels.
**Elect. Developm.*	*Electrical Developments.* Electrical Machinery Development Centre, 5 Svitavska, Brno 2.
**Cienc. e Invest.*	*Ciencia e Investigación.* Avda R. Sáenz Peña 555, Buenos Aires.
F & G Rdsch.	*F & G Rurdschau.* Felten & Guilleaume Carlswerk, Cologne-Mülheim.
Latv. PSR Zin. Akad. Vēst.	*Latvijas PSR Zinātnu Akademijas Vēstis.* Ul Kommunalnaya 4, Riga.
Luz y Fuerza	*Luz y Fuerza.* Editorial Gabel, General Goded 1, Madrid.
**Math. Gaz.*	*Mathematical Gazette.* Royal Naval College, Greenwich, S.E.10.
**Proc. 7th Int. Congr. Appl. Mech.*, 1948	*Proceedings of the 7th International Congress on Applied Mechanics.* [Abstracted by *Applied Mechanics Reviews.*]
Telefunken Ztg	*Telefunken Zeitung.* Technischwissenschaftliche Mitteilungen der Telefunken Gesellschaft für drahtlose Telegraphie, Mehringdamm 32–34, Berlin, S.W.61.
Trans. Roy. Soc. S. Afr.	*Transactions of the Royal Society of South Africa.* University of Cape Town, Rondebosch.

ORIGINAL ARTICLES

It is regretted that the articles from which abstracts are made cannot be supplied on loan, nor can copies or microfilms of them be supplied. Application should be made to appropriate lending libraries, or to the publishers of the journals concerned; publishers' addresses, wherever known, are given in the List of Journals (see above). Assistance will be gladly given in cases of particular difficulty.

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Thus the appearance of an abstract in *Science Abstracts* may generally be taken as an indication that the original is publicly available, and information for its identification and acquisition, if not given in the abstract, will be found elsewhere in *Science Abstracts.*

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ABSTRACTING JOURNALS

Abstracts have been reprinted from other Journals with the kind permission of the following organizations, to whom grateful acknowledgment is made:—

Applied Mechanics Reviews	4049 Pennsylvania, Kansas City 2, Missouri.
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Int. Inst. Refrigeration	Institut International du Froid, 9 Avenue Carnot, Paris (XVIIe).
Math. Tables Aids to Computation	*Mathematical Tables and Other Aids to Computation.* National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C.
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Sci. Instrument Research Association	17 Princes Gate, London, S.W.7.

The names of some other Journals of Abstracts covering subjects related to Physics and Electrical Engineering are listed below:—

Aeronautical Engineering Review (New York)
Building Science Abstracts (D.S.I.R., London)
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Journal of the Society of Glass Technology (Sheffield)
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Road Abstracts (D.S.I.R., London)
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Transactions of the Institute of Welding (London)

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The abstracts are classified by subject according to the Universal Decimal Classification, and arranged in order of their U.D.C. numbers, which are printed at the head of the Abstract on the right.

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Abridged tables of certain sections were published with the January (1949) issues of *Science Abstracts*, by permission of the British Standards Institution, and a few reprints of these tables are available from The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

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SYMBOLS USED IN THE U.D.C.

: links numbers denoting subjects dealt with in relation to each other in the article

\+ links numbers denoting subjects dealt with independently in the article

/ indicates extension over several numbers (e.g. 535.41/.43 represents 535.41 to 535.43 inclusive)

( ) signifies Place (e.g. (485), in Sweden)

– is used to attach special analytical subdivisions applicable to certain sections (e.g. –31, ultra-violet; hence 535.34–31, ultra-violet absorption)

.0 indicates other analytical subdivisions applicable throughout Sections 53/59 (e.g. .08, measurement; hence 536.63.08, measurement of specific heat)

. Numbers are normally divided into groups of three digits by stops for convenience

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The initial "A" is used to indicate an abstract prepared from the summary published with the article.
If no indication of language is given in the abstract, the article may generally be assumed to be in English. This does not necessarily hold, however, for abstracts reprinted from elsewhere.

MATHEMATICS 51

512.972

1. On complex tensor calculus. N. N. GHOSH. *Bull. Calcutta Math. Soc.*, **42**, 65–72 (*June*, 1950).

The calculus is developed in close analogy to the ordinary treatment of Eddington, which is restricted to real co-ordinates. The metric tensor is complex, but the metric of the complex space is real and is a generalized form of the line-element defined in general relativity. Einstein's gravitational equations are generalized to admit complex co-ordinates. For Maxwell's equations a special metric is defined, which is invariant under Lorentz transformations. The generalized electromagnetic equations are then obtained. L. S. GODDARD

517.43

2. Notes on operators $F = \sum_{k=0}^{k=n} F_k(x)\left(\frac{d}{dx}\right)^k$ P. T. LANDSBERG. *Math. Gaz.*, **33**, 113–15 (1949).

A set of $n + 1$ equations between the coefficients $F_k(x)$ are shown to be the necessary and sufficient conditions for an operator of the above type to be hermitian. A longer proof was previously known [H. C. Lee, *Chin. J. Phys.*, **6**, 86 (1946)]. Conditions for the operators of the above type to commute are considered, and, except for a trivial case, it is shown that operators of the above type cannot be idempotent. P. T. LANDSBERG

517.43 : 530.145

3. The characterization of quantum-mechanical operators. J. L. B. COOPER. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 4) 614–19 (1950).

A maximal hermitian operator is defined and attention is confined to such operators. A self-adjoint operator is characterized in terms of (i) motion of a dynamical system, (ii) constant of the motion. This characterization comes nearer to having a physical significance than those usually given. L. S. GODDARD

517.514.3

4. On the expansion of a Coulomb potential in spherical harmonics. B. C. CARLSON AND G. S. RUSHBROOKE. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 4) 626–33 (1950).

Two systems of spherical polar co-ordinates are considered, with parallel axes, but different origins. Two points are considered, one referred to each co-ordinate system. The reciprocal of the distance between the points is expanded in a series of spherical harmonics. S. MICHAELSON

517.941

5. The generalized response of linear systems for arbitrary initial conditions. J. R. MOORE. *J. Appl. Phys.*, **21**, 933–5 (*Sept.*, 1950).

A method is presented for the solution of ordinary linear differential equations with constant coefficients. This method stays wholly in the time domain and obtains a general solution in a compact form including the effects of initial conditions. The differential equation as treated involves a driving function made up of the sum of terms involving the system input and its derivatives. The general solution is also given in terms of weighting functions operating on the input (in the driving function) and including outside the weighted integral, terms involving initial conditions of the input as well as the dependent variable. A.

517.942.922

6. A new method for the evaluation of zeros of Bessel functions and of other solutions of second-order differential equations. F. W. J. OLVER. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 4) 570–80 (1950).

The zeros of the solutions of the equation, $w'' + p(x)w' + q(x)w = 0$, are shown to satisfy a certain non-linear differential equation. The latter is integrated numerically to yield the zeros. The method described in the paper is new, and important since it makes practical the calculation of zeros otherwise unobtainable. The only condition is that the zeros be fairly regularly spaced. The method enjoys the advantage that it is independent of tabulated values of the actual solutions. Detailed application to the zeros of $J_n(x)$ and $Y_n(x)$ is described. L. S. GODDARD

518.42

7. Grapho-analytical method of solving algebraic equations of high degrees. O. M. BOGATYREV. *Elektrichestvo, No.* 8, 71–8 (*Aug.*, 1950) *In Russian.*

High speed of solution and an accuracy of three signs is claimed for this method of obtaining roots of equations—of fourth degree with all roots, fifth degree, sixth degree with at least a pair of real roots, sixth degree with all roots, seventh degree. This method including splitting of high-degree functions into their simpler component functions, which are easier to plot, is explained in detail and numerical examples are quoted. J. LUKASZEWICZ

518.5

8. Design principles of all purpose digital computers. A. D. BOOTH. *Acta Phys. Austriaca*, **4** (*No.* 1) 85–97 (1950).

Description, in general terms, of a binary, parallel machine with a one-address instruction code. S. MICHAELSON

518.5 : 517.512.2

9. A simple machine capable of Fourier synthesis calculation. J. H. ROBERTSON. *J. Sci. Instrum.*, **27**, 276–8 (*Oct.*, 1950).

A machine for one-dimensional Fourier summation. It can handle sine or cosine waves, of wave-number up to 15 and amplitude up to 40. It is capable of results accurate to about $\pm$ 2 units when the average amplitude of the terms is 15–20 units. For continuous addition of terms, it employs a new principle based on the multiple reflexion of a beam of light on a set of pivoted mirrors. A.

518.5 : 621.316.313 : 621.317.39

10. Solution of simultaneous equations through use of the a.c. network calculator. L. M. HAUPT. *Rev. Sci. Instrum.*, **21**, 683–6 (*Aug.*, 1950).

Kirchhoff's law equations may be written for any

electrical network. Conversely, it is usually possible to find an electrical network whose Kirchhoff-law equations are similar to the given set of simultaneous equations. The equations may be solved by measuring the corresponding quantities in this analogous network. The a.c. network calculator is adaptable to this method of solution. The bases are set down for finding the correct electrical network for a given set of simultaneous equations. A.

518.5 : 621.317.39

11. Arithmetic operations in a binary computer. R. F. SHAW. *Rev. Sci. Instrum.*, **21**, 683–93 (*Aug.*, 1950).

The application of binary arithmetic in the computing circuits of a high-speed digital computer is discussed in detail covering, with numerous examples, the use of complements to represent negative numbers, the corrections necessary in the multiplication process as a result of the use of complements, and additional modifications of the process to simplify mechanization. A special division method well-adapted to automatic computer use is described, and round-off procedures are noted briefly. The storage of negative numbers as absolute values with a sign rather than in complement form is discussed. A.

518.5 : 621.317.39

12. Accuracy of electric circuits destined for solving Laplace equations. M. L. BYKHOVSKIĬ. *Izv. Akad. Nauk, SSSR, Otdel. Tekh. Nauk, No.* 4, 489–526 (*April*, 1950) *In Russian.*

Measuring errors and those due to the change of differential equations into algebraic are not considered. Characteristic errors of linear and two-dimensional circuits, resulting from inaccuracy of its elements and from inaccurate application of e.m.f.'s and currents (limiting conditions) are analysed. Recommendations for rational designs of such circuits are upheld by examples. J. LUKASZEWICZ

518.5 : 621.317.39.088

13. Errors in calculations carried out by a calculating board. M. S. LIBKIND. *Izv. Akad. Nauk, SSSR, Otdel Tekh. Nauk, No.* 3, 357–73 (*March*, 1950) *In Russian.*

The universal calculating board of the Akad. *Nauk, S.S.S.R.* is an electrical analogue circuit for the rapid solution of complex engineering problems. Errors due to an only approximate substitution of the investigated system by electric circuits are not considered. Errors due to (1) deviations of actual from nominal values of elements of the circuit, (2) stray losses resulting from capacitances and resistances of conductors between these elements, (3) characteristics of electrodynamic instruments with valve amplifiers in the measuring circuit, are estimated as 2%, which was experimentally confirmed.

J. LUKASZEWICZ

518.5 : 621.317.733 : 621.318.572

14. The curve computer. W. E. K. MIDDLETON. *Canad. J. Res. F*, **28**, 324–32 (*Aug.*, 1950).

An electromechanical instrument has been developed, which adds, subtracts, multiplies, or divides the ordinates of two curves in Cartesian co-ordinates, plotting the resulting locus. This uses the principle of the Wheatstone bridge, and is semi-automatic; the curves are followed manually, but a phase-sensitive servo system keeps the bridge in balance. Attachments are provided for determining the area under the resulting curve, and also for the performance of certain logarithmic operations of interest in photometry. In the ordinary use of the computer, the accuracy is about 0·3% of full scale or better. A.

519.2

15. Stochastic processes relating to particles distributed in a continuous infinity of states. A. RAMAKRISHNAN. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 4) 595–602 (1950).

A general method is described for dealing with the statistics of a number of particles, when the E-space (E is a parameter characterizing the states) is a continuum. By this means it is possible to study the moments and the distribution functions of various stockastic variables related to transitions, e.g. collision loss, radiation loss by fast particles or pair creation by high-energy photons. Application is made to the statistical problem of cosmic radiation.

L. S. GODDARD

519.241.1 : 530.162

16. The statistics of correlated events. I. C. DOMB. *Phil. Mag.*, **41**, 969–82 (*Oct.*, 1950).

An attempt to formulate the mathematical properties of events occurring in time with a correlation between them. One effect of the correlation is a change in the mean square deviation of the number of events occurring in an interval of time t. By analogy with the shot effect in the presence of space change, this is denoted by a factor Γ^2 for large t, and Γ^2 is evaluated in terms of the interval distributions between events. For finite intervals t a corresponding factor $\gamma^2(t)$ is introduced, which usually tends to 1 as $t \to 0$. A correlation function between events occurring at times separated by an interval τ is defined, and its relation to $\gamma^2(t)$ is discussed. A generalization of Campbell's Theorem applying to correlated events is derived. Finally the problem of the random partitioning of correlated events is discussed. A.

519.25

17. A note on control area. T. M. STOUT. *J. Appl. Phys.*, **21**, 1129–31 (*Nov.*, 1950).

Control area, or the integrated error for a step function input, has been used as a measure of control system performance. An expression for the control area is derived, a simple method of evaluation presented and some limitations of the control area criterion mentioned. A.

519.272 : 534.44

18. Short-time autocorrelation functions and power spectra. R. M. FANO. *J. Acoust. Soc. Amer.*, **22**, 546–50 (*Sept.*, 1950).

The reciprocal relations between autocorrelation functions and power spectra, known as Wiener's Theorem, are extended in a modified form to the case of experimental results obtained by means of filters with finite time constants. Equations are given which may be used to relate the autocorrelation-function representation of a speech wave to the corresponding spectrographic representation. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.982.7

19. The effect of film errors on astrometric accuracy. G. LAND. *Astron. J.*, **55,** 141–6 (*Aug.*, 1950).

A continuation of an earlier account (*Astron. J.*, **50,** 51, 1942) of processed emulsion errors on plates used for parallax measures. It is here shown that effects due to displaced photographic images in the emulsion layer may be either reduced or eliminated by: (i) combining differential measures on double-exposure plates to form weighted means; (ii) combining separate (single-exposure) plates of the sample star field on nights sufficiently near in date to yield substantially identical parallax factors; (iii) restricting measured stellar images to central area of plate to include only those images showing equally directed displacements; (iv) increasing the effective central area by using plates of larger dimensions with the same focal length of lens. Such increase of the elliptic central area will be roughly ∝ the increase in total plate area. In general, for cameras of short focal length, image errors will be large. D. R. BARBER

523.112 : 530.12

20. On the general motion of matter on the cosmological scale. A. GIÃO. *C.R. Acad. Sci., Paris,* **231,** 605–6 (*Sept.* 25, 1950) *In French.*

Matter associated with a slightly deformed de Sitter universe is found in general to be in a state of rotational motion. It is suggested that this may explain the rotation of the galaxies. R. A. NEWING

523.112 : 530.12

21. The expanding universe a decisive test of the theory of relativity? L. GIALANELLA. *Ric. Sci.*, **20,** 911–24 (*July*, 1950) *In Italian.*

Observational consequences of the general theory are discussed, and various interpretations of the nebular red-shifts are reviewed. R. A. NEWING

523.162

22. A radiation-absorbing centre in a non-statical homogeneous universe. P. C. VAIDYA. Letter in *Nature, Lond.*, **166,** 565 (*Sept.* 30, 1950).

523.165

23. Radio astronomy. M. RYLE. *Rep. Phys. Soc., Progr. Phys.*, **13,** 184–246 (1950).

Experimental methods are described; then the results of observations of galactic and solar radiation are presented. Theories covering these observations are put forward, the aim being a connected treatment. Particular emphasis is placed on the experimental and theoretical work, carried out since the war, at the Cavendish Laboratory. The report is complementary to the recent surveys by Hey [Abstr. 1388 (1950] and by Pawsey [Abstr. 32 (1951)].

L. S. GODDARD

523.165

24. Cosmic rays as the source of general galactic radio emission. K. O. KIEPENHEUER. Letter in *Phys. Rev.*, **79,** 738–9 (*Aug.* 15, 1950).

523.165 : 537.591.1

An hypothesis on the origin of the cosmic radiation. *See Abstr.* 416

523.4

25. Planetary and satellite atmospheres. G. P. KUIPER. *Rep. Phys. Soc. Progr. Phys.*, **13,** 247–75 (1950).

A review of spectroscopic, visual and photographic observations of planetary atmospheres. For greater detail see the author's monograph [Abstr. 4298 (1949)]. L. S. GODDARD

523.53

26. I. On the determination of the age of meteor streams. II. On the mutual influences of particles in a meteor stream. M. PLAVEC. *C.R. Acad. Sci., Paris,* **231,** 454–6 (*Aug.* 16); 469–70 (*Aug.* 21, 1950) *In French.*

I. The dynamical effects of solar radiation are treated as perturbations, and the secular changes of orbital elements discussed for various ranges of particle size, and for various major streams. It is found that for a given stream, the minimum distance from the Earth rapidly increases as the diameter of the particles falls below a critical value. Such an effect would manifest itself as a "crochet" in the observed magnitude-frequency curve of the shower. The position of the "crochets," which have been observed by Watson, enable the ages of the individual showers to be calculated. II. The mutual effects of the particles of a stream are examined assuming that the particles are sufficiently large to absorb the solar radiation completely and re-emit it isotropically. Consideration is given to the Poynting–Robertson effect [see also Abstr. 4620 (1950)]. Mutual forces are found to be negligible in a typical stream. M. W. OVENDEN

523.59 : 551.593.9

27. Photographic isophotes of the counterglow. D. A. ROJKOVSKY. *Astron. J., USSR,* **21** (*No.* 1) 34 (1950) *In Russian.* English abstract in *Astron. News Letter* [*Harvard*] *No.* 51, 5 (*Aug.* 31, 1950).

Isophotes of 30 photographs, corrected for various forms of instrumental distortion, are given and discussed. The centre of the isophotes is several degrees removed from the anti-solar point, and a diurnal parallax of $3\frac{1}{2}°$ is indicated. The nature of the particle formation causing the counterglow is discussed. M. W. OVENDEN

523.59 : 551.593.9

28. On the gaseous tail of the earth. V. G. FESSENKOV. *Astron. J., USSR,* **27** (*No.* 2) 89 (1950) *In Russian.* English abstract in *Astron. News Letter* [*Harvard*] *No.* 51, 8–9 (*Aug.* 31, 1950).

The discovery is announced of the "false zodiacal light" which takes the form of an unsymmetrical extension of the counterglow (see also Rojkovsky in preceding Abstr.). The author rejects the meteoric hypothesis of the counterglow for various reasons, among them the existence of a diurnal parallax as determined by Rojkovsky and others, and discusses the observation by Karimov that the spectrum of the counterglow shows a 10% strengthening of the night-sky emission lines rather than a continuous spectrum. Geometrical data lead to the conclusion that the earth has a gaseous envelope flattened along the

ecliptic with a tail-like extension away from the sun, and showing a curvature similar to cometary tails. M. W. OVENDEN

523.6

29. On the structure of cometary nuclei and the formation of meteor streams. A. D. DUBIAGO. *Astron. J., USSR*, **27** (*No.* 1) **5** (1950) *In Russian.* English abstract in *Astron. News Letter* [*Harvard*] *No.* 51, 2–3 (*Aug.* 31, 1950).

The author discusses the mechanical properties of cometary nuclei and their disintegration, in particular the model of a nucleus consisting of numbers of solid particles which mutually collide. The equations of motion of cometary particles indicate that the period of all particles in the nucleus is a function of the density of the nucleus only, and by identifying this period with that of the brightness changes observed by Brobovnikoff, values of density between 10^{-6} and 10^{-8} for various comets are deduced. The diameter of the nucleus of Halley's comet is found to be 400 km, from Vorontzev–Velyaminov's estimate of the mass. The escape of small particles formed from collisions is examined, and it is estimated that a few thousand years would be required for the meteors to be uniformly distributed around the comet's orbit. M. W. OVENDEN

532.72

30. On an attempt to discover a real intensity distribution at the extreme edge of the Sun's disk. P. TEN BRUGGENCATE, H. GOLLNOW AND F. W. JÄGER. *Z. Astrophys.*, **27** (*No.* 3) 223–36 (1950) *In German.*

Observations of the optical density distribution at the extreme boundary of the solar disk during a partial eclipse, made in red light (6 400 Å), indicate a connexion between optical depth, τ, and temperature, T, which departs from the theoretical de Jäger–Voight curve over the range of τ, 0·0 to 0·4. Between $\tau = 0{\cdot}1$ and $\tau = 0{\cdot}2$ there appears a slight temperature inversion ($\Delta T = -250°$K). D. R. BARBER

523.72 : 538.566.2 : 621.396.822

31. A radio-frequency representation of the solar atmosphere. S. F. SMERD. *Proc. Instn Elect. Engrs, Pt III*, **97**, 447–52 (*Nov.*, 1950) [*Reprint No.* 1024].

The paper is a collection of solar data derived from optical observations, and originally compiled for use in "solar noise" studies. An elementary description of the solar atmosphere is followed by mean values of electron density, electron temperature and magnetic field as functions of height in the chromosphere and corona. An assumed general magnetic field, and magnetic fields due to sunspots, are each treated. The data are finally presented in terms of plasma, gyro and collision frequencies, which quantities are fundamental to the magneto-ionic theory. Levels of zero refractive index and their significance are discussed and the effect of prominences is considered. A.

523.72 : 621.396.822

32. Solar radio-frequency radiation. J. L. PAWSEY. *Proc. Instn Elect. Engrs, Pt I*, **97**, 290–310 (*Sept.*, 1950) [*Reprint No.* 839].

Surveys research on solar r.f. radiation up to 1948. The observed characteristics of solar noise of cm-m range are described, including intensity, region of origin on the sun, association with visual phenomena, and polarization; on the basis of these characteristics a classification of types of solar noise is proposed. Known data on the generation and propagation of radio waves in the solar atmosphere are outlined, and the mode of origin is discussed. A thermal component is recognized corresponding in intensity to black-body radiation of a temperature that rises from $10^{4°}$K at 1 cm to $10^{6°}$K at a few metres. This change is believed to be associated with a rise in the region of origin of the radiation from the lower chromosphere to the corona. Non-thermal components, prominent at metre wavelengths, are subject to remarkably rapid variations and reach occasional peak intensities 10^3–$10^6\times$ the thermal ones. They are believed to originate in some form of electrical disturbance in the solar atmosphere. A.

523.74 : 534.222.2

33. On the propagation of shock-waves in the solar atmosphere. H. SCHIRMER. *Z. Astrophys.*, **27** (*No.* 2) 132–52 (1950) *In German.*

Hydrodynamical and thermodynamical aspects of shock-wave transmission through the H convective zone of the solar atmosphere are considered. It is shown that disturbances moving with velocities of from 8 to 10 km/sec cause up to as much as 7-fold increases of pressure, over time intervals of 60 to 80 sec. Such compressions are associated with increases of temp. up to 10 000° K. D. R. BARBER

523.75 : 523.165 : 537.591.1

Solar flares and the origin of cosmic radiation. *See Abstr.* 417

523.752

34. The derivation of a model solar chromosphere from radio data. J. H. PIDDINGTON. *Proc. Roy. Soc. A*, 417–34 (*Oct.* 10, 1950).

An empirical relationship between the equivalent black-body temperature of the sun's disk and the radio-frequency is derived from experimental results. An expression for the absorption coefficient of radio waves in the solar atmosphere is developed so that, by Kirchhoff's principle, it is possible to determine the emission from each level and hence the overall emission in terms of known or assumed conditions. The coronal and chromospheric components of radiation are separated and their distributions over the solar disk are determined theoretically. From the reduced radio data an equation is derived relating the optical depth of a given level in the chromosphere with electron temperature at that level. Optical depth may be expressed as a function of electron temperature and density so that the equation may be used to check the validity of any proposed model chromosphere. A.

523.755

35. Statistics of the green coronal rays. M. WALDMEIER. *Z. Astrophys.*, **27** (*No.* 3) 237–46 (1950) *In German.*

The statistical investigation of the distribution of the monochromatic coronal rays (observed in the green line 5303) has established two zones of coronal activity: the principal zone and the polar zone. The principal zone starts with sunspot-maximum and is dying out at about the minimum of the following cycle. It coincides with the zone of sunspots and faculae. The polar zone begins at sunspot-minimum

and ends at the sunspot-maximum of the following cycle. During the first few years the polar zone is moving from 45° to 60° heliographic latitude; then it becomes stationary there till the next minimum of sunspot activity, when it resumes its motion towards the poles, reaching these at about the time of sunspot-maximum and thereafter dying out. A.

523.755

36. A new method of observing the solar corona. B. LYOT. *C.R. Acad. Sci., Paris*, **231**, 461–4 (*Aug.* 21, 1950) *In French.*

A brief description is given of the principles involved in the construction of a new type of spectro-photometer with which the author has been able to detect and measure the intensity of the green coronal line 5 302·85 at sea level without the necessity of taking special precautions to reduce instrumental scattered light. The radiation outside the limb of the sun passes through a birefringent monochromator of band-pass about 2 Å, the last polaroid of which has been removed. The photoelectric polarimeter described by the author previously [Abstr. 2660 (1948)] enables the light at the coronal line wavelength to be compared with that in two symmetrically-placed bands 4 Å apart, any excess at the coronal wavelength being due to the coronal radiation. Owing to the presence of a nearby solar absorption line which causes some East–West assymetry in the zero because of solar rotation, a compensating inclined plate is provided. A typical coronal distribution curve is given. M. W. OVENDEN

523.77

37. Recent advances in infra-red solar spectroscopy. L. GOLDBERG. *Rep. Phys. Soc. Progr. Phys.*, **13**, 24–43 (1950).

A general survey; but emphasis is given to recent work, in the region 1·4–3·6 μ, carried out at the McMath–Hulbert Observatory. An atlas of the i.r. spectrum, to be published soon, is briefly described. Detailed data is given concerning the telluric absorption, which produces well-defined band systems of H_2O, CO_2, CH_4 and N_2O. L. S. GODDARD

523.83

38. A note on the theory of stellar dynamics. I. J. TUOMINEN. *Prok. K. Ned. Akad. Wet.*, **53** (*No.* 7) 1049–55 (1950).

The components of average velocity and the values of $\overline{U^2}$, $\overline{V^2}$, $\overline{UV}$ have been derived for a flat and rotationally symmetrical stellar system with the mass concentrated in the centre. The values found satisfy, of course, the hydrodynamical equations of motion. A.

523.83

39. A study of the space motions of the stars. P. P. PARENAGO. *Astron. J., USSR*, **27** (*No.* 3) 150 (1950) *In Russian.* English abstract in *Astron. News Letter* [*Harvard*] *No.* 50, 8–11 (*Aug.* 21, 1950).

Data from 3 000 selected stars give the elements of the solar motion. High-velocity giants are treated separately from other giants, being believed to be members of systems of different degrees of flattening; all stars of this group are identified with the upper branch of Baade's Population II. The sun's component motions are given with respect to the following sequences: (i) highly flattened (interstellar gas, B-type, long-period Cepheids, supergiants, open clusters); (ii) flattened (A, gA–gF, gF, gG–gM, R, N); (iii) intermediate (red semi-regular and irregular, Mira-variables except $P = 150$–200^d, subgiants, white dwarfs, planetary nebulae, dG–dM); (iv) spherical (Mira-variables $P = 150$–200^d, subdwarfs, high-velocity giants, globular clusters, short-period Cepheids). The solar motions are plotted against spectral type for main-sequence stars, discontinuities occurring between F and G. The suggestion that the main-sequence consists of two groups, flattened subsystem O–F and intermediate subsystem G–M, is discussed from various cosmogonical viewpoints. The connections between the kinematical properties of the various subsystems and the spatial distribution of the stars is discussed. A value for $a = 0{\cdot}01122 \pm 0{\cdot}00033$ in Strömberg's parabolic relation V_θ (circular) $- V_\theta$ (observ) $= a R^2$ is obtained, but the relation is criticized. On the assumption of a steady-state in the galaxy, the solar motion with respect to the circular galactic rotation is obtained from the highly-flattened systems. Using also the observed density gradient a value of V_θ (circular) $= 233 \pm 9$ km/sec is obtained without having to assume that the globular cluster system is without rotation. The motions of the principal subsystems with respect to the galactic centre are given. The difference between the galactic centre of star density and the direction perpendicular to the circular rotation in the neighbourhood of the sun is taken to indicate that the flattened subsystems spiral inward, the members of the spherical systems, on the contrary, moving outwards. The author suggests that while stars of the spherical subsystems were produced near the galactic centre, those of the flattened systems were produced far from it and that as the galaxy evolves, in a time of the order of 10^{11} years these latter will form an irregular aggregation similar to the Magellanic clouds.

M. W. OVENDEN

523.83

40. Dynamics of star streaming. II. P. STEHLE. *Astrophys. J.*, **112**, 299–306 (*Sept.*, 1950).

Previous work [Abstr. 1411 (1950)] on an extension of Chandrasekhar's treatment of stellar dynamics is continued. The potential energy of the star system is assumed to be subject to 2 1st-order differential equations, and it is shown that, as a consequence, only systems with plane, cylindrical, or spherical symmetry are possible. The results are applied to a system whose mass is concentrated in a point nucleus, yielding a spherically symmetrical potential. A.

523.83 : 523.854.3

41. On a forgotten paper by M. A. Kovalsky. D. J. MARTYNOV. *Astron. J., USSR*, **27** (*No.* 3) 169 (1950) *In Russian.* English abstract in *Astron. News Letter* [*Harvard*] *No.* 50, 12 (*Aug.* 21, 1950).

Attention is drawn to the investigation of systematic stellar motions and galactic rotation by Kovalsky, published in the Scientific Papers of Kazan University for 1860. M. W. OVENDEN

523.85

42. On the determination of the convergent point of a moving cluster from proper motions. A. BROWN. *Astrophys. J.*, **112**, 225–39 (*Sept.*, 1950).

Several methods are discussed, representing, in the main, different ways of utilizing the position

angle, θ, as observed for each star, and it is desirable to see if they would be affected by the form of the frequency distribution expected for θ. With reasonable assumptions as to the distribution of the errors of the observed quantities, namely, the components of proper motion, it is possible to derive the frequency distribution of θ, and this suggests an alternative method of solution which would appear to have some advantages over the existing methods. As an illustration of the method, its application to the nucleus stars of the Ursa Major cluster is considered. It is emphasized that there is still an appreciable uncertainty associated with the determination. A.

523.851

43. The problem of RZ Ophiuchi. W. LOHMANN. *Z. Astrophys.*, **27** (*No.* 2) 161–6 (1950) *In German.*

A lower limit for the combined mass of the system of 6 solar masses is derived from the rotational velocity of the gaseous ring surrounding the cF5 component. Observed radial velocities set an upper limit of 9 solar masses. M. W. OVENDEN

523.854.3

44. The time of rotational relaxation of the galaxy. S. A. KAPLAN. *Astron. J., USSR*, **27** (*No.* 3) 177 (1950) *In Russian.* English abstract in *Astron. News Letter* [*Harvard*] *No.* 50, 12 (*Aug.* 21, 1950).

The author discusses the effect of the non-potential component of the gravitational field of the galaxy (equivalent to the Coriolis force), and obtains a value for the relaxation time some 1 000 times smaller than that obtained by considering only the smoothed potential field. This is still too large to be of importance in stellar dynamics, but in small, compact and rapidly rotating systems the relaxation time may become as small as 10^{11} years; it is suggested that this is the cause of the uniformity in structure of the elliptical nebulae. M. W. OVENDEN

523.855

45. The effect of irregular absorption on galaxy distribution. C. WARWICK. *Proc. Nat. Acad. Sci., Wash.*, **36**, 415–23 (*Aug.*, 1950).

A statistical analysis of the apparent distribution of galaxies on Mount Wilson plates is used to examine the distribution of small dark clouds ($\sim$ 16pc diameter). Neither the hypothesis of uniform absorption or of absorption entirely due to small dark clouds explains the observations when the zone of avoidance is included, indicating that in the zone of avoidance there must occur either larger clouds, or a non-random distribution of small clouds. Distribution between galactic latitudes $\pm 40°$ and $\pm 60°$ shows clustering of galaxies, but no indication of irregular absorption. Between latitudes $\pm 15°$ and $\pm 30°$, outside the zone of avoidance, the evidence is incomplete, but consistent with condensation into small clouds, which must be smaller than 15pc in diameter. The mean absorption of a single cloud is recomputed following Ambarzumian, but allowing for clustering of galaxies, a smaller value of 0·08 being obtained.

M. W. OVENDEN

523.875

46. A theoretical Hertzsprung–Russell diagram for red dwarf stars. J. B. OKE. *J. Roy. Astron. Soc. Can.*, **44**, 135–48 (*July–Aug.*, 1950).

A series of stellar models for main sequence stars of small masses is studied in conjunction with two possible sources of energy, the C cycle and the *p–p* reaction. Hertzsprung–Russell diagrams are obtained assuming the two sources of energy separately. These are compared with observational data. It is found that the main sequence should have a considerable width if moderate variations in the chemical compositions of stars are present. The conclusions are that the C cycle models fit the observed data best. The *p–p* reaction models do not fit as well, but do give a solution for the H and He content of the sun in good agreement with spectroscopic evidence. A.

523.877

47. An empirical temperature scale fixed by the mass-luminosity relationship. K. PILOWSKI. *Z. Astrophys.*, **27** (*No.* 3) 193–222 (1950) *In German.*

523.877

48. Contours of the Balmer lines and the surface temperature of a star. D. CHALONGE AND L. DIVAN. *C.R. Acad. Sci., Paris*, **231**, 331–3 (*July* 31, 1950) *In French.*

The method of determining stellar temperatures from residual intensities of Balmer lines [Abstr. 8457 (1950)] is applied to α Lyr. and α CMa. in which the contours are compounded of sharp cores from the extended atmospheres plus shallow stark-broadened absorptions from lower levels. The latter only are used in determining intensities for this purpose. Resulting temperatures, with known values of magnitude and parallax, yield stellar diameters in good agreement with accepted values, thus supporting the proposed method. D. L. EDWARDS

523.877

49. The problem of red giants and cepheid variables. G. GAMOW AND C. LONGMIRE. Letter in *Phys. Rev.*, **79**, 743–4 (*Aug.* 15, 1950).

523.877

50. The cooling of white dwarfs. S. A. KAPLAN. *Astron. J., USSR*, **27** (*No.* 1) 31 (1950) *In Russian.* English abstract in *Astron. News Letter* [*Harvard*] *No.* 51, 4 (*Aug.* 31, 1950).

The author investigates the thermal radiation of white dwarfs, and concludes that for the sequence of faint white dwarfs the process of cooling of a degenerate star is able to explain the observed luminosities, but for the bright sequence a thermonuclear reaction may be required. The author suggests that the white-dwarfs and sub-dwarfs are related, and thus criticizes the assumption (by Shatzman) that the core consists only of heavy atoms, while the outer parts consist of pure H.

M. W. OVENDEN

523.877

51. The radiation of stellar envelopes in the absence of radiative equilibrium. V. V. SOBOLEV. *Astron. J., USSR*, **27** (*No.* 2) 81 (1950) *In Russian.* English abstract in *Astron. News Letter* [*Harvard*] *No.* 51, 7–8 (*Aug.* 31, 1950).

The assumed sudden increase of stellar temperature produces ionization and radiation, the brightness of the star increasing until equilibrium is reached. The transition process is considered for both optically thin and optically thick layers, the results being shown in the form of plots of the ratio of neutral atoms to

all atoms against the initial optical depth of the level concerned for various values of a parameter which is essentially a measure of the time elapsed. It is shown that the envelope can be considered as consisting of two sharply bounded regions, the inner one ionized and the outer un-ionized, the increase of ionization taking the form of an outward migration of the boundary. The time of relaxation is deduced for various electron densities. The results are applied to the observational data on Nova Herculis, and compared with the analysis of Grotrian.

M. W. OVENDEN

523.877

52. Investigation of the mass-luminosity-radius relation. P. P. PARENAGO AND A. G. MASEVICH. *Astron. J., USSR* **27** (*No.* 3) 137 (1950) *In Russian.* English abstract in *Astron. News Letter* [*Harvard*] *No.* 50, 7–8 (*Aug.* 21, 1950).

In a discussion of previous investigations (Parenago 1936, 1939; Kuiper 1938; Russell and Moore 1940; Lvov 1939; Lundmark 1940; Lohmann 1948) emphasis is laid upon the temperature dependence of the mass-luminosity law given by Parenago in the form $M = L^{0.3}T^{-\frac{1}{2}}$. In a complete rediscussion of available data on 242 stars, an attempt is made to establish for each sequence of the Hertzprung–Russell diagram an empirical relationship $L = 10^x M^y R^z$ where x may depend upon the mean molecular weight. The results, mean errors and correlation coefficients of x, y and z are tabulated for the groups: (i) main sequence 0–G4; (ii) main sequence G7–M; (iii) subdwarfs; (iv) subgiants; (v) giants; (vi) supergiants, for each group 3 least-squares solutions being made.

M. W. OVENDEN

523.877

53. Remarks on the connection between the Rosseland and Chandrasekhar values for the opacity in stellar atmospheres. P. TEN BRUGGENCATE. *Nachr. Wiss. Göttingen, Math.-phys. Kl., IIa* (*No.* 2) 7–13 (1950) *In German.*

The two procedures would be equivalent only for exact calculations. If a grey atmosphere is taken as a 1st approximation, only the Rosseland mean gives convergence to an isotropic radiation field at large optical depths.

R. A. NEWING

523.877

54. Scattering by a moving electron atmosphere and its effect on spectral lines. I. The Schuster problem. F. N. EDMONDS, JR. *Astrophys. J.*, **112,** 307–23 (*Sept.*, 1950).

The problem of the transfer of radiation in an atmosphere of free electrons undergoing differential expansion is solved in the first approximation under the conditions of the standard Schuster problem of line formation. It is further assumed that electron scattering is in accordance with the frequency-independent Thomson scattering coefficient, the Rayleigh phase function, and a Maxwellian distribution of thermal velocities. In the solution, account is taken of the noncoherent character of the scattering due to velocities arising from the thermal and mass motions of the electrons. The solution for radiation emerging from the atmosphere contains terms for unscattered and scattered radiation. The latter contains a function which represents the spectra distribution of scattered radiation for incident monochromatic radiation.

A.

523.877

55. Scattering by a moving electron atmosphere and its effect on spectral lines. II. The planetary nebula problem. F. N. EDMONDS, JR. *Astrophys. J.*, **112,** 324–36 (*Sept.*, 1950).

The problem of the transfer of radiation in a planetary nebula undergoing differential expansion and consisting of free electrons in thermal motion is solved in the first approximation for the emergent radiation. In the solution, account is taken of the noncoherent character of the scattering, which is due to the thermal and mass motions of the electrons. The solution for the emergent radiation represents radiation of the incident flux from the central star, which has suffered scattering by electrons in the nebula. The solution contains a function which describes the spectral distribution of scattered intensity for incident monochromatic flux.

A.

523.877 : 523.75

56. The thermodynamic structure of the outer solar atmosphere. II. Comment on empirical determinations of b_n and T_e. R. N. THOMAS. *Astrophys. J.*, **112,** 337–42 (*Sept.*, 1950).

An apparent discrepancy between several empirical determinations of b_n and T_e is investigated. The former is resolved, while the latter is only partially so. It appears that scattered "photospheric" radiation contributes non-negligibly to the chromospheric eclipse Balmer continuum and that there is consequently a slight polarization to be expected throughout the chromosphere.

A.

523.877 : 523.75

57. Superthermic phenomena in stellar atmospheres. VI. Comment on regions of emission fluctuation in the solar atmosphere. R. N. THOMAS. *Astrophys. J.*, **112,** 343–51 (*Sept.*, 1950).

Regions of fluctuating emission in the solar atmosphere must involve density fluctuations, independently of whether there is a simultaneous change in excitation. Such density fluctuation must be discussed in terms of a non-static model. One such model may be a supersonic jet, and a quantitative description of such a jet is provided by an extension, to the case including a gravitational field, of an early theory by Prandtl. The theory is applied to the Menzel–Cillié "hot-spot" region observed at the 1932 eclipse.

A.

523.877 : 523.162

58. The dynamics of stellar passage through a cloud of meteoric material. T. A. AGEKYAN. *Dokl. Akad. Nauk. SSSR,* **69** (*No.* 4) 515–18 (1949) *In Russian.*

The problem of accretion of the stellar masses through attraction of cosmic dust is examined quantitatively. No special assumption is made regarding the trajectory of the star with respect to the cloud and an arbitrary velocity distribution is assumed for the individual dust particles. The analysis provides the means of excluding all particles that collide with relative velocities larger than a critical value, for

which they are turned into gas and thus repelled by the star's radiation pressure. The author has tried to solve the problem in the most general case and no attempt has been made to give any numerical results. Only for the sun are optimum conditions computed; these could presumably have led to the formation of a planetary system.

MATHEMATICAL REVIEWS

527

59. Application of Liouville's approximation to the blind navigation problem. J. J. GILVARRY AND S. H. BROWNE. Letter in *J. Appl. Phys.*, **21**, 1195–6 (*Nov.*, 1950). See Abstr. 6982 (1950).

527.6

60. The pursuit course. R. H. BACON. Letter in *J. Appl. Phys.*, **21**, 1065–6 (*Oct.*, 1950).

Further discussion. See Abstr. 843 (1949).

529.7 : 621.317.361

61. The determination of time and frequency. H. M. SMITH. *Instn Elect. Engrs Paper* 1054, 11 *pp.* [*Early proof issue*].

Some astronomical problems now have a direct bearing on modern developments in frequency measurement by the electrical engineer. A short account is given of the various known causes of irregularities in the rate of rotation of the Earth, their effects on time determination and the means adopted to allow for them so that a uniform system of time may be established. A brief survey is given of the operational equipment at present used in the national time service. Attention is drawn to the small discrepancies between the legally-defined Greenwich Mean Time, which is still required for navigation and survey work, and the uniform time system appropriate elsewhere. A.

PHYSICS 53

53.081.4 : 538.3

Rational and non-rational treatment of the electromagnetic field. *See Abstr.* 513

FUNDAMENTALS 530.1

530.12

62. Einstein's new unified relativistic theory. B. FINZI. *Ric. Sci.*, **20**, 901–10 (*July*, 1950) *In Italian.*

This expository article discusses the general theory and Weyl's unified theory, and concludes with a brief account of Einstein's new theory [Abstr. 4684 (1950)].

R. A. NEWING

530.14

63. The relativistic behaviour of systems with or without self constraint. E. KEBERLE AND A. MERCIER. *Arch. Sci.*, **3** (*No.* 3) 235–41 (1950) *In French.*

It is suggested that unconstrained systems can be described in terms of 4-vectors or tensors, and constrained systems in terms of entities which transform like an interval of space or time. R. A. NEWING

530.145

64. Some remarks on the relativistic quantum field theory. T. NAGAKURA. Letter in *Progr. Theor. Phys.*, **5**, 502–3 (*May–June*, 1950).

530.145

65. Stationary states in the relativistic quantum theory of wave-fields. W. HEISENBERG. *Z. Naturforsch.*, **5a**, 367–73 (*July*, 1950) *In German.*

A suitable formulation of the problem within the covariant theory is first considered. In case the Hamiltonian is not Hermitean, the theory is then considered using an S-matrix $S = T(T^*T)^{-\frac{1}{2}}$ where T^* is the Hermitean conjugate of T and T is constructed from the Hamiltonian in the same way as the usual S-matrix. G. J. KYNCH

530.145

66. On the covariant formalism of the quantum theory of fields. I. R. UTIYAMA. *Progr. Theor. Phys.*, **5**, 437–58 (*May–June*, 1950).

Space-time points may be specified by flat coordinates (x) or by a parametric set (ξ) with corresponding metric. The implications of invariance of a classical field theory under (x) transformations or (ξ) transformation are derived, and exemplified by the translation and Lorentz groups. Special restrictions are noted for invariance under a generalized gauge transformation. The commutation relations in quantum field theory are shown invariant under (x) and (ξ) transformation and the Tomonaga–Schwinger formalism is shown to be a special case when the (ξ) transformations are suitably restricted. The form of the integrability conditions in interaction representation is also considered. R. H. DALITZ

530.145

67. On the convergence of the integrals in the problem of vacuum polarization. L. DE BROGLIE. *C.R. Acad. Sci., Paris*, **230**, 2061–3 (*June* 12, 1950) *In French.*

The e^2-vacuum polarization integrals of the Feynman formalism become convergent when the interaction energy between the electromagnetic and electron fields is modified to that of an earlier theory of the author [Abstr. 242 (1950)]. It is shown how the corresponding convergence factor may be given a suitable covariant form. R. H. DALITZ

530.145

68. Symmetrical quantization. W. THIRRING. *Acta Phys. Austriaca*, **4** (*No.* 1) 125–8 (1950) *In German.*

The time-dependent commutation relations arising from a formalism symmetric in space and time are shown to follow inevitably without any correspondence assumptions but that of relativistic invariance.

G. J. KYNCH

530.145

69. A new method for the treatment of longitudinal and scalar photons. K. BLEULER. *Helv. Phys. Acta*, **23** (*No.* 5) 567–86 (1950) *In German.*

Gupta has introduced an alternative method of quantization for the Maxwell field which differs from the usual one in that the scalar part of the field is quantized by means of the indefinite metric of Dirac. It is shown that this method can be extended into a

general and consistent theory, including the case of interaction with electrons. Some of the advantages are: the difficulty of normalizing a state vector satisfying the Lorentz-condition no longer occurs. For processes taking place within long time-intervals the photon-vacuum can consistently be stated in the form $A_\mu^+(x)\psi_0 = 0$. Gauge invariance is exhibited in a peculiar direct way. It is shown, by a canonical transformation, that the theory is equivalent to the reduced theory where the longitudinal field is eliminated, and replaced by the static Coulomb-interaction. All physical results are therefore identical with those of the ordinary theory. Lorentz invariance is exhibited in a simple way. A.

530.145

70. A theory of elementary particles using differential equations. K. WILDERMUTH. *Z. Naturforsch.*, **5a**, 373–81 (*July*, 1950) *In German.*

A theory of elementary particles without divergences must differ from the usual Hamiltonian form unless a cut-off at high momenta is introduced. Equations are set up and quantized assuming that the particle is described by a set of interacting fields. Assuming the fusion of spinor particles to give additional particles it is shown that a photon could be obtained from the fusion not of electron and positron, but of proton and anti-proton. G. J. KYNCH

530.145

71. Quantization of higher order equations. W. THIRRING. *Phys. Rev.*, **79**, 703–5 (*Aug.* 15, 1950).

The prescription for quantization of a field is formulated in a manner such that one gets directly the commutator function, which turns out to be a regularized D function for a field obeying a higher order equation. A.

530.145

72. On the quantization of Einstein's gravitational field equations. F. A. E. PIRANI AND A. SCHILD. *Phys. Rev.*, **79**, 986–91 (*Sept.* 15, 1950).

Weiss' method of quantization of field theories characterized by first-order Lagrangians can be carried out in a non-metrical "amorphous" space, as was first stated by Bergmann and Brunings. The gravitational equations can be regarded as differential equations for the field variables $g_{\mu\nu}$ in an amorphous space and the quantization procedure can be applied to them. The gravitational field equations are written in canonical form, the Hamiltonian being a function of generalized co-ordinates, momenta and velocities. This Hamiltonian is obtained using a method developed by Dirac for Lorentz invariant theories. A.

530.145

73. Attempts at a non-linear electrodynamics. K. BECHERT. *Ann. Phys., Lpz.*, **7** (*No.* 7–8) 369–409 (1950) *In German.*

A number of assumptions and invariance conditions must be satisfied by any theory which describes the motion of particles of finite mass and charge and only deviates at short distances from classical electrodynamics. The condition that the field correctly describes such a motion can be expressed in the form $S_\mu T_{\mu\nu} = BS_\nu$, where S_μ is the current 4-vector and $T_{\mu\nu}$ the energy-momentum tensor. Assuming the classical field equations there remains only one choice of the relation between certain invariants of the theory. For a simple choice the equations have a spherically symmetric solution with a shortest length r_0. Other properties and possibilities of the theory are considered. G. J. KYNCH

530.145

74. Second order current corrections for boson fields. D. C. PEASLEE. *Helv. Phys. Acta*, **23** (*No.* 5) 490–2 (1950).

Radiative corrections to the current operator have been computed to 2nd-order, using β-matrix formalism for the boson field. In addition to the self-energy and vacuum-polarization corrections, there occur infinite corrections to the dipole and quadrupole moments (which cancel for the scalar representation). In higher orders, all surface-dependent terms (such as the interaction Hamiltonian contains) vanish, and divergencies are no more severe than those in the 2nd-order corrections. R. H. DALITZ

530.145

75. On the elimination of the normal-dependent part from the Hamiltonian. K. NISHIJIMA. *Progr. Theor. Phys.*, **5**, 405–11 (*May–June*, 1950).

If the interaction Hamiltonian contains the derivatives of the fields, terms arise depending on the normal to the space-like surfaces appearing in the formulation. Such terms can be eliminated by an alteration in the P-bracket. G. J. KYNCH

530.145

76. Bremsstrahlung in high energy nucleon-nucleon collisions. A. SIMON. *Phys. Rev.*, **79**, 573–6 (*Aug.* 15, 1950).

Field-theoretic calculations are made of the electromagnetic radiation accompanying a proton–neutron collision. The nucleons are treated non-relativistically, and it is assumed that their scattering is produced either by a scalar meson field with scalar coupling or a pseudoscalar field with pseudoscalar coupling. The resulting energy spectrum for the photons has the form $(\frac{1}{2}E_0 - ck)^{\frac{1}{2}}dk/k$ for the scalar field and $(\frac{1}{2}E_0 - ck)^{\frac{1}{2}}kdk$ for the pseudoscalar field. The ratio of the intensity at 90° to 0° (in the CM system) is about 100 for the scalar theory and about 1 for the pseudoscalar case for incident energies of about 200 MeV. Integrated cross-sections are obtained for both theories. The yield decreases with energy for the scalar field and increases for the pseudoscalar field. A.

530.145

77. On the interaction of mesons with the electromagnetic field. I. T. KINOSHITA. *Progr. Theor. Phys.*, **5**, 473–88 (*May–June*, 1950).

The S-matrix theory for mesons interacting with the electromagnetic field has been shown to be formally identical with that for electrons, when the electron γ-matrices are replaced by the meson β-matrices, and to contain no surface-dependent terms such as are present in the initial interaction Hamiltonian. Second-order current corrections for the meson fields are derived from this S-matrix and the resultant divergences may not all be interpreted as renormalization effects. The vacuum polarization corrections are evaluated in greater detail.

R. H. DALITZ

530.145

78. On the formulae for normalization and mean values, for the photon and particles of spin higher than ½. S. SLANSKY. *C.R. Acad. Sci., Paris*, **231**, 404–6 (*Aug.* 7, 1950) *In French.*

From a consideration of particles of higher spin as treated as a fusion of spin ½ particles it is shown that there may be ambiguity arising from the time variables when the reduction is made leading to the particle density in ordinary space, as opposed to space-time.

G. J. KYNCH

530.145

79. Differential identities in three-field renormalization problem. A. SALAM. Letter in *Phys. Rev.*, **79**, 910–11 (*Sept.* 1, 1950).

Identities analogous to those of Ward [Abstr. 6241 (1950)] in the photon-electron problem are derived for the scalar meson–nucleon–photon problem, and some infinite renormalization constants are shown to be related in a way necessary for the success of the renormalization programme in this three-field problem. The method used also implies, for example, the finiteness of all neutron magnetic moment graphs.

R. H. DALITZ

530.145 : 539.18

80. Radiative corrections to decay processes. I. Meson decay. S. HANAWA AND T. MIYAZIMA. *Progr. Theor. Phys.*, **5**, 459–72 (*May–June*, 1950).

The decay period of a scalar meson with scalar coupling (constant g) to electron-neutrino field is evaluated, including secónd-order radiative corrections, from Schwinger's expression for total transition probability [Abstr. 1511 (1950)]. Low energy divergence in the corrections is cancelled by the infra-red divergence in the decay with simultaneous photon emission [Abstr. 2736 (1950)]. Renormalization of g is not unique—a provisional prescription leads to a 5% correction to the period for meson mass 210 m_e. The self-energy operator of a scalar meson is briefly discussed.

R. H. DALITZ

530.145

81. Structure of electron in λ-process. K. SAWADA. Letter in *Progr. Theor. Phys.*, **5**, 497–8 (*May–June*, 1950).

To determine how convergence is almost obtained in the λ-limiting process, the interaction energy is expressed as the sum of three terms. Modifications are then suggested to achieve convergence.

G. J. KYNCH

530.145 : 535.12 : 539.18

82. The production of mesons by photons. K. A. BRUECKNER. *Phys. Rev.*, **79**, 641–50 (*Aug.* 15, 1950).

The general features of the process of photo-meson production are discussed on a semiclassical basis and also on the basis of perturbation theory in the weak coupling approximation applied to scalar, pseudoscalar, vector, and pseudovector meson theory. These calculations are carried out with the Feynman–Dyson methods to give covariant expressions for the cross-sections. The corrections of next higher order in the meson–nucleon coupling are calculated for pseudoscalar mesons and are shown to give large contributions. Comparison of the conclusions of the theory with the experimental results seems to indicate that the meson is of spin zero and is closely bound to the nucleons as is characteristic of pseudoscalar theory.

A

530.145

83. Non-physical solutions in classical finite electron theory. J. IRVING. *Proc. Phys. Soc., Lond. A*, **63**, 1125–31 (*Oct.*, 1950).

An approximate linear form of the Peierls–McManus equations of motion for an electron is shown to yield runaway solutions for a particular influence function, which otherwise satisfies all the conditions imposed by the theory. The general problem is to discuss the existence of complex roots of a transcendental equation for an arbitrary form of the influence function. It is shown that this equation always has roots. These, however, may be such that the corresponding motion of the free electron is of a damped nature. It has not been found possible to construct a function which avoids runaway solutions or to prove whether or not such a function exists when all conditions are satisfied.

A.

530.145

84. On the new mode of interaction between spinor fields. S. OZAKI, S. ÔNEDA AND S. SASAKI. Letter in *Progr. Theor. Phys.*, **5**, 491–2 (*May–June*, 1950).

Assuming pseudospinor fields (a suggestion of Yang, as yet unpublished) meson decay of the type $\mu \rightarrow e + 2\mu_0$ would give new results, but not the other types of μ-e decay. New couplings also would occur in the π-μ decay scheme if n and p are pseudospinors.

G. J. KYNCH

530.145

85. The phenomenological theory of exchange currents in nuclei. R. K. OSBORN AND L. L. FOLDY. *Phys. Rev.*, **79**, 795–802 (*Sept.* 1, 1950).

As was first pointed out by Siegert, the existence of exchange forces in nuclei implies the existence of accompanying exchange currents. Sachs has calculated an expression for these, by making the Hamiltonian containing exchange potentials gauge-invariant, and has applied it to the calculations of exchange magnetic moments in H^3 and He^3. The Hamiltonian obtained by Sachs is not the most generally admissible one. More generally, the exchange current density is found to depend on a vector function whose irrotational part is completely determined by gauge-invariance but whose solenoidal part is arbitrary except for the requirements (following from conditions of translational invariance and symmetry in all nucleons on the Hamiltonian) that it be translationally invariant and antisymmetric under the exchange of the spin and space co-ordinates of each pair of nucleons. Making use of these conditions on the Hamiltonian, the explicit form of the dependence of the solenoidal part of the exchange current upon the spin and isotropic spin co-ordinates of the nucleons has been derived. In the resultant exchange moments, the irrotational part leads to the expression obtained by Sachs, while the solenoidal term contribution contains the spin operators of the nucleons in particular combinations, together with arbitrary functions of the nucleon separation. Villars' exchange moment expression, as obtained from meson theory, is included as a special case and hence the exchange

contributions to the moments of H^3 and He^3 are explicable on a phenomenological basis, contrary to the results obtained in Sachs' special case. The generality and significance of the results are discussed in relation to the various meson theories. A.

530.145 : 539.152.1

86. A differential equation for the phase in neutron-proton scattering. O. BERGMANN. *Acta Phys. Austriaca*, **4** (*No.* 1) 62–70 (1950) *In German.*

A differential equation for a phase function $\delta(r)$ is obtained, this function tending to the asymptotic phase as $r \to \infty$. Integration gives an equation which, e.g. for *S*-waves, is

$$\delta = \text{const.} \int_0^\infty v(r) \sin^2 (kr + \delta(r)) dr$$

The equation is solved for the square well.

G. J. KYNCH

530.145 : 539.18

87. μ-pair theories and the π-meson. G. WENTZEL. *Phys. Rev.*, **79**, 710–17 (*Aug.* 15, 1950).

The μ-pair theory suggests the interpretation of the π-meson as a pair of μ's bound together by a nucleon pair field. Only a non-relativistic description, involving a cut-off in the momentum spaces, is attempted. Various π-meson types, such as are well known from the conventional Yukawa theories, can be constructed, depending on the type of coupling adopted in the interaction Hamiltonian of the pair theory. It appears, however, that only the pseudoscalar coupling, which leads to a pseudoscalar π-meson, is consistent with the experimental data; e.g. on the nuclear scattering of μ's, which indicate that the interaction of μ's with nucleons, at least in such processes, is rather weak. Then, also, the creation of μ-pairs in high energy nuclear collisions is expected to be an infrequent event, compared to the π-creation. Nonetheless, the μ-pair production should furnish a crucial experimental test. Another process predicted is the dissociation of a fast π-meson, passing through matter, into a pair. The existence of heavier mesons, involving more than two μ's, seems likely. A.

530.145 : 539.18

88. On the use of the Tomonaga intermediate coupling method in meson theory. K. M. WATSON AND E. W. HART. *Phys. Rev.*, **79**, 918–25 (*Sept.* 15, 1950).

It is shown that the Tomonaga method for obtaining an intermediate coupling approximation in meson theory can be formulated very simply and will in general give accurate results in the limits of weak and strong coupling. The problem of nuclear forces in the charged scalar theory is studied. The ratio of ordinary to exchange forces is given as a function of the coupling strength. Photo-meson production is studied in the intermediate coupling region for both charged scalar and charged pseudoscalar theories. The method is seriously limited in that nucleon recoil is neglected. A.

530.145.6

89. Galilean approximation of the relativistic wave-particle attribution. E. KEBERLE. *Arch. Sci.*, **3** (*No.* 3) 242–6 (1950) *In French.*

It is noted that the relativistic invariance of the momentum 4-vector for de Broglie waves does not become Galilean invariance for small velocities.

R. A. NEWING

530.145.6

90. On de Broglie's theory of elementary particles. H. HÖNL AND H. BOERNER. *Z. Naturforsch.*, **5a**, 353–66 (*July*, 1950) *In German.*

The method of de Broglie which derives wave-equations for particles of spin $\frac{1}{2}N$ by assuming a fusion of N Dirac particles is considered in detail for $N = 2$ and 3. For $N = 2$ the earlier results of Kemmer are reproduced. For $N = 3$ one representation is trivial, one of the others of order 16 represents states of mass m and $3m$, spin eigenvalues $\frac{1}{2}$, $\frac{3}{2}$, the other of order 20 also has mass eigenvalues m and $3m$, and spin $\frac{1}{2}$, $\frac{3}{2}$. The g-factors are calculated for these states. G. J. KYNCH

530.145.6

91. The virial theorem and the variation principle. I. ISENBERG. Letter in *Phys. Rev.*, **79**, 737 (*Aug.* 15, 1950).

530.145.6

92. Comments on a solution of the wave equation. A. VISCONTI. *C.R. Acad. Sci., Paris*, **231**, 507–9 (*Sept.* 4, 1950) *In French.*

It is shown how to obtain an expression for the wave function in perturbation theory without solving the wave equation. Use is made of de Broglie waves subjected to a certain diffusion law. The comments can be made to apply also to positron theory.

J. JACOBS

530.145.61

93. Eigenfunction problems with periodic potentials. E. C. TITCHMARSH. *Proc. Roy. Soc. A*, **203**, 501–14 (*Oct.* 24, 1950).

The expansion of an arbitrary function in terms of the solutions of the differential equation $d^2\phi/dx^2 + \{\lambda - q(x)\}\phi = 0$ is obtained in the case where $q(x)$ is a periodic function of x. A.

530.145.63

94. The S-matrix in the Heisenberg representation. C. N. YANG AND D. FELDMAN. *Phys. Rev.*, **79**, 972–8 (*Sept.* 15, 1950).

A method is described whereby the *S*-matrix can be formulated directly in the Heisenberg representation. This has the advantage over the customary formulation in the interaction representation in that the concepts of space-like surfaces and their normals need never be introduced. Quantum electrodynamics and the β formalism of charged mesons are treated as illustrative examples; in particular, it is shown that general rules for writing down the elements of the *S*-matrix for the latter case may be immediately inferred. In the second part of this paper, a covariant procedure, independent of the canonical formalism, is carried out for making the transition from the Heisenberg to the interaction representation and is applied to several typical cases; in this way, the *S*-matrix of the Heisenberg picture is identified with that of other authors. A.

530.162

95. The statistics of honeycomb and triangular lattice. II. I. Syozi. *Progr. Theor. Phys.*, **5**, 341–51 (*May–June*, 1950).

For Pt I, see Abstr. 7752 (1950). A representation of the abstract algebra is found and a solution of the eigenvalue problem. In the application to the thermodynamic properties of large crystals the specific heat becomes logarithmically infinite at the Curie point, as in Onsager's theory. The case of antiferromagnetism in the triangular lattice is discussed.

J. JACOBS

530.162

96. On the question of intermediate statistics. H. Müller. *Ann. Phys., Lpz.*, 7 (*No.* 7–8) 420–4 (1950) *In German.*

This paper deals with statistics, intermediate between the Fermi and the Bose statistics, by a method which differs from that originally employed by Gentile [*Nuovo Cim.*, **17**, 493 (1940)]. Probabilities are calculated from consideration of the volume available to individual particles, by introducing a proper volume (b_i) in phase space of a particle belonging to the ith energy range. The energy distribution of the particles is derived, using Stirling's theorem and the method of the most probable distribution. It differs from Gentile's result and shows that $b_i = 0, 1, -1$ corresponds to the Boltzmann, Fermi and Bose statistics respectively. Hence models are discussed to which an intermediate statistics might apply. [Misprint in author's reference to Gentile's paper, which should read as above.]

P. T. LANDSBERG

530.162 : 519.241.1

The statistics of correlated events. I. *See Abstr.* 16

530.162 : 531.396

97. Several remarks concerning the many-body problem in the formulation of A. A. Vlasov. S. V. Tyablikov. *J. Exp. Theor. Phys., USSR*, **20**, 16–22 (*Jan.*, 1950) *In Russian.*

Vlasov worked out a self-consistent field method for application to the theory of the plasma, with solutions obtained by the method of retarded and accelerated potentials [Vlasov, *Sci. Rep. Moscow State University*, **75** (*No.* 2) *Pt I* (1945)]. The present author ciriticizes the extension of these methods by Vlasov to the theory of condensed phases and the general problem of the theory of many bodies [Abstr. 461 (1949)].

BROOKHAVEN GUIDE TO RUSSIAN LITERATURE

530.162 : 531.396

98. Theory of nonlocalized particles. Remarks concerning the article of S. V. Tyablikov. A. A. Vlasov. *J. Exp. Theor. Phys., USSR*, **20**, 23–6 (*Jan.*, 1950) *In Russian.* See preceding Abstr.

530.162 : 533.7

99. Condensation phenomena in a clustering Bose–Einstein gas. W. Band. *Phys. Rev.*, **79**, 871–6 (*Sept.* 1, 1950).

It has been shown that Mayer's theory of imperfect gases can be handled approximately as a problem in association in which the actual gas is replaced by a mixture of ideal gases consisting of clusters of all sizes and between which dissociative equilibrium exists. Kahn and Uhlenbeck have shown how Mayer's theory can be generalized to apply to quantum degenerate gases. The purpose of the present paper is to examine the clustering approximation to such a theory of the quantum degenerate Bose–Einstein gas. The symmetrized wave functions for the clustering assembly are set up and the partition function evaluated for all ways of clustering. Equations of state are deduced that include condensation into the liquid phase as a clustering avalanche at the saturation pressure. It is found that clustering has the effect of lowering the lambda-temperature due to statistical degeneracy right down to the saturated vapour line, so that the lambda-transition is entirely inhibited from the gas phase. A.

530.162 : 536.48

Non-equilibrium phenomena in a Bose–Einstein gas. *See Abstr.* 263

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.25

100. Summarized proceedings of a conference on stress analysis, London, 1950. E. K. Frankl. *Brit. J. Appl. Phys.*, **1**, 241–51 (*Oct.*, 1950).

Brittle lacquers: In a paper entitled "Developmental work on a brittle lacquer suitable for experimental stress analysis" (C. H. Young) the properties required of a strain-indicating coating were given in detail together with an outline of the research carried out to produce a successful lacquer. This was described under the headings (*a*) preliminary survey of potential film formers, (*b*) development of resin, (*c*) nature of plasticizer and solvent. The lacquer, marketed under the name Strainlac, is similar to the American Stress-coat but is believed to be more sensitive to strain and less sensitive to temperature changes. It consists of a metallic resin complex, suitably plasticized with dibutyl phthalate and dissolved in carbon disulphide. The precautions to be observed and the dangers of use were fully described. Strainlac must be sprayed on in an efficient down-draught extraction booth or applied in the open air; a respirator must be worn. Full details of the method of use were given. Mention was made of creep and lines of further research indicated.

The use of models in structural work: Papers by E. M. Lewis, J. A. H. Paffett and P. J. Palmer dealt with structural, marine and aeronautical engineering problems respectively. In structural engineering, models of celluloid are built and stressed at a point. By the use of the reciprocal theorem the redundant reactions of a structure can be deduced from a knowledge of the ratios of the deflections at the points of application of the loads and reactions. In marine engineering a combination of photo-elastic and strain gauge methods of analysis is used. For aeronautical engineering the use of xylonite was discussed and the non-dimensional parameters characterizing static and dynamic stress listed and commented upon. The use of the British Celanese

Woven Gauge on models and the method of recording amplitude, phase and frequency at resonance was mentioned.

Recent developments in photo-elasticity: The papers in this section were: "Marco resin as a photo-elastic model material" (H. Fessler) and "Photo-elastic investigations on diamond crystals" (P. Grodzinski). A third paper by H. J. Jessop, relating to frozen stress models, has been published elsewhere [Abstr. 7923 (1950)]. The optically most sensitive composition of Marco was given and values for its material fringe value, Young's modulus and optical modulus are 4·7 lb/in/fr, 2 800 lb/sq in, and 600 fr/in respectively. The paper on diamonds gave a brief review of previous work and of the author's work on rough diamonds used for dies. Mention was made of a method for the actual determination of the stresses in diamond tools and of the use of diamonds for an optical dynamometer.

Application of experimental stress analysis methods to soil mechanics problems: A paper entitled "A strain gauge dynamometer rig for the determination of soil force on plough bodies" (J. C. Hawkins) dealt with the measurement of the forces acting on the component parts of ploughs. A paper by A. W. Bishop described a method for the laboratory measurement of the coefficient of earth pressure at rest. Details were given of a tri-axial type apparatus used for saturated samples of sand. A further paper, "A multi-channel string galvanometer for use with wire resistance strain gauge," by A. A. Wells, is published elsewhere [*J. Sci. Instrum.*, **27**, 59 (*March*, 1950), Abstr. 1781 B (1950)].

Stress analysis in the motor industry: A paper entitled "A portable strain gauge equipment for use on motor cycles" (R. S. Bennett) described in some detail the equipment which has given very satisfactory results on bumper tests in a factory. A second paper, by L. F. Atkinson, dealt briefly with the use of Stresscoat and strain gauges. H. G. JERRARD

531.25

101. On the solution of the equilibrium equations of elasticity in general curvilinear coordinates. W. Freiberger. *Aust. J. Sci. Res. A*, **2**, 483–92 (*Dec.*, 1949).

A system of stress functions consisting of a harmonic vector and a harmonic scalar potential is introduced into the equations of equilibrium of an isotropic elastic body in arbitrary curvilinear co-ordinates and tensor form. The components of displacement and of the stress tensor are expressed in terms of these potentials and it is shown that the total number of independent components of the potentials is reducible to three. The tensor equations are then specialized to orthogonal curvilinear co-ordinates and expressions derived for the "physical" components of displacement and stress in terms of the stress functions. Reference is made to the relation between the present approach and previous ones. A.

531.55

102. Space rocket trajectories. S. Herrick. *J. Brit. Interplan. Soc.*, **9**, 231–45 (*Sept.*, 1950).

The timing and the direction of the thrust applied to a space rocket during its take-off from the earth are discussed from the point of view of "variation of constants" (or variation of parameters). Conclusions: (1) the thrust period should be ended as early as possible, and (2) assuming that the thrust is tangent to the trajectory, the direction of the tangent is almost immaterial for great distances (but with some preference for the vertical). For interplanetary flights a special property of two-body motion is shown to simplify the estimation of the minimum velocity necessity to carry a rocket to its objective. A.

531.571

103. Stability of flow in a rocket motor. D. F. Gunder and D. R. Friant. *J. Appl. Mech.*, **17**, 327–33 (*Sept.*, 1950).

An analytical treatment of "chugging" (pressure pulsation) in rocket motors. Four mathematical treatments are given, the most successful being based on Nyquist's regeneration theory [*Bell Syst. Tech. J.*, **11**, 126–47 (*Jan.*, 1932)]. Nyquist diagrams for stable and unstable systems are derived, and both monopropellant and bipropellant rockets are considered. A. C. CLARKE

MECHANICAL MEASUREMENTS 531.7

531.724

104. A simplified air flow method for the determination of the surface area of powders. G. Kraus and J. R. Thiem. Letter in *J. Appl. Phys.*, **21**, 1065 (*Oct.*, 1950).

MECHANICS OF FLUIDS 532

532.122 : 534.614

105. Temperature variation of the compressibility of molten sodium. T. E. Pochapsky and S. L. Quimby. Letter in *Phys. Rev.*, **79**, 892 (*Sept.* 1, 1950).

532.123 : 539.42

106. The limiting hydrostatic tension of water near 0°C. J. C. Fisher. Letter in *J. Appl. Phys.*, **21**, 1068 (*Oct.*, 1950).

532.13

107. Viscosity of metallic liquids. T. P. Yao and V. Kondic. Letter in *Nature, Lond.*, **166**, 483 (*Sept.* 16, 1950).

It is generally assumed that the relationship of viscosity (η) of metallic liquids to the temperature T is given by $\eta = A \exp B/RT$ [see Desch. *Proc. Inst. Brit. Foundrymen*, **37**, 30, 77 (1936)] and that this holds true to the m.p. of the metal. Experimental results obtained with molten Sn, Pb and certain binary alloys indicate that this is not so; the value of η changes very markedly a few degrees above the m.p. Measurements of η for alloys in the Sn–Zn system indicate a marked correlation between η and composition, when η is plotted at a constant temperature above the liquidus for the system.

J. S. G. THOMAS

532.13 : 532.73

108. The concentration dependence of viscosities in dilute solutions. R. Simha. *J. Coll. Sci.*, **5**, 386–92 (*Aug.*, 1950).

At very low concentrations, at which the solute molecules either retain their identity and original shape or form low-order aggregates, the concentration dependence of the reduced specific viscosity η_{sp}/c results from two factors, hydrodynamic interaction, and aggregation. An expression for the latter and a simplified description of the former are presented. On the basis of the complete theory previously given, the effect of particle shape and solvent is discussed. A.

532.137

109. The determination of the viscosity of molten metals. M. R. Hopkins and T. C. Toye. *Proc. Phys. Soc., Lond. B*, **63**, 773–82 (*Oct.*, 1950).

Measurement may be made up to temperatures of about 900°c. The metal is contained in a cylindrical crucible which is allowed to oscillate about its axis under the control of the torsion in a suspension wire. The theory of the method is considered. The viscosity of Zn has been determined in the temperature range 430°c to 480°c and the results are given. A.

532.137

110. Scheme for analyzing capillary measurements on non-Newtonian liquids. O. H. Clark and M. L. Deutsch. Letter in *J. Appl. Phys.*, **21**, 1195 (*Nov.*, 1950).

See Abstr. 7050 (1950). Acknowledgment of prior authorship of formulas. A.

532.137

111. Original authorship of formulas given in Clark and Deutsch's paper. M. Reiner and G. W. Scott-Blair. Letter in *J. Appl. Phys.*, **21**, 1195 (*Nov.*, 1950). See Abstr. 7050 (1950).

532.517.4 : 535.55

112. Turbulence in apparatus for measurement of streaming double refraction. H. G. Jerrard. *J. Appl. Phys.*, **21**, 1007–13 (*Oct.*, 1950).

The different apparatus used by some 30 investigators, who have induced double refraction in a liquid contained in the annular gap between two concentric cylinders, are examined with particular reference to the onset of turbulence. In the case where the outer cylinder alone rotates, curves are given which easily enable the critical gradients corresponding to the dimensions of the apparatus to be found. The results of the examination are so tabulated that present and future workers in this field can quickly decide on the significance of the measurements obtained by any of the investigators. An explanation is put forward of the surprising fact that with either the inner or outer cylinder rotating measurements of double refraction apparently show no very sharp break between regions of laminar and turbulent flow. The value of making simultaneous measurements of streaming double refraction and viscosity is pointed out and the advantages of using an apparatus with rotating outer and stationary inner cylinder are briefly summarized. Mention is made of optical design. A.

CAPILLARITY 532.6

532.613.5 : 532.614.2

113. Concerning the dependence of the surface energy and surface tension of spherical drops and bubbles on radius. T. L. Hill. *J. Amer. Chem. Soc.*, **72**, 3923–7 (*Sept.*, 1950).

The approximate model used by Fowler to investigate theoretically the surface energy and surface tension of a plane liquid surface is extended to spherical drops and bubbles, with the additional assumption of liquid incompressibility. It turns out to be possible to derive a very simple expression for the correction (to the plane surface tension) owing to curvature, which predicts that the surface tension decreases with radius. However, the magnitude of the effect is not large in this zero-order approximation. A.

532.62

114. A note on the critical area of surface films and evaporation through them. D. S. Subrahmanyam. *Indian J. Phys.*, **24**, 271–5 (*June*, 1950).

Considering the rise of water in two capillary tubes introduced into a basin of water in an isolated system, the surface of water in one of the tubes being contaminated, it is shown theoretically that the surface tension cannot fall in value until the contamination prevents direct communication between the water and vapour phases. A new explanation is thus offered for the existence of critical area of surface films. The theory also throws light on evaporation through surface films and it is pointed out that while Rayleigh's theory explains the phenomena connected with condensed films the new theory will be helpful in explaining the existence of critical area of liquid expanded films. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

115. On lattice theories of the liquid state. H. M. Peek and T. L. Hill. *J. Chem. Phys.*, **18**, 1252–6 (*Sept.*, 1950).

The Lennard-Jones and Devonshire theory of the liquid state has been modified by introduction of the quasi-chemical method to allow for both holes in the liquid and an expandable lattice. The essential step is to minimize the free energy with respect to a lattice expansion parameter. On the whole, critical constants obtained in this way are in appreciably better agreement with experiment than those of the Lennard-Jones and Devonshire theory. However, the equilibrium number of holes turns out to be much too small. A.

532.7 : 534.321.9

116. Ultrasonic studies in electrolytes. I. Alkali halides. B. Krishnamurty. *J. Sci. Industr. Res.*, **9B**, 215–19 (*Sept.*, 1950).

Ultrasonic methods have been employed for studying the influence of concentration on the viscosity and surface tension of aqueous solutions of 4 alkali

halides, KI, KBr, KF and NaF. The viscosity-concentration curves show a maximum at 0·3 mol. concn. in all the 4 cases. The surface tension increases with concn. in all the cases. In the range of concns. studied, the following empirical relationships hold good: (1) $\eta = 2{\cdot}0 \times 10^2\beta$ and (2) $T = 1{\cdot}2 \times 10^{-6}\rho v^{\frac{3}{2}}$, where β represents adiabatic compressibility; ρ, density; and v, ultrasonic velocity. A.

532.7 : 534.321.9

117. Ultrasonic velocity in organic solutions. K. C. LAL. Letter in *Curr. Sci.*, **19**, 240–1 (*Aug.*, 1950).

532.7 : 534.321.9

118. Ultrasonic investigation of liquids. VI. Acetylene derivatives. A. WEISSLER AND V. A. DEL GROSSO. *J. Amer. Chem. Soc.*, **72**, 4209–10 (*Sept.*, 1950).

The velocity of sound in 11 liquid derivatives of acetylene has been measured at 20° and at 30°. In every case, the adiabatic compressibility of a 1-alkyne is smaller than that of the *n*-paraffin or 1-alkene having the same number of C atoms. For the C ≡ C bond, the molar sound velocity increment varies from 194 to 253 in these 11 compounds; the average value is 225. A.

532.7 : 536.48

The zero-point energy of helium. *See Abstr.* 264

532.712

119. Modification of the apparatus used for the Baldes thermoelectric method of measuring osmotic pressure. V. E. KINSEY. *Rev. Sci. Instrum.*, **21**, 767–8 (*Aug.*, 1950).

The apparatus has been modified by substituting a breaker-type d.c. a.c. amplifier for a sensitive galvanometer, thereby permitting its use under conditions where galvanometers are impractical. Precise temperature control of the water bath in which the thermo-elements are immersed has been shown to be unnecessary provided the bath is stirred vigorously. A switch made from one block of electrolytically pure Cu provides a satisfactory current-reversing mechanism with low interfering contact potentials arising from non-thermostated portions of the circuit. A.

532.72

120. Research on thermodiffusion in the liquid phase. I. PRIGOGINE, L. DE BROUCKÈRE AND R. AMAND. *Physica*, **16**, 577–98 (*July–Aug.*, 1950) *In French.*

Experiments on thermodiffusion of binary organic solutions by the thermogravitational method are described. The separation curves are discussed in connection with the "forgotten effect." For nearly perfect solutions, the Soret coefficient D'/D is independent of the composition. The sign of D'/D is determined by the difference of the cohesion densities (energy of vaporization/molar volume) of the pure constituents. The constituent with higher density of cohesion is enriched at the cold wall. A derivation of this rule based on the elementary theory of transport phenomena in liquid phase is given. A.

532.72 : 536.7

121. The thermodynamics of some non-isothermal systems. L. D. TUCK. *J. Chem. Phys.*, **18**, 1128–34 (*Sept.*, 1950).

The thermodynamic theory of non-isothermal systems of liquid solutions is treated by the method of Tolman and Fine, which method includes consideration of the irreversible processes in calculating the conditions of the steady state. The concept entropy of transfer of a dissolved molecule is discussed in terms of the interaction of the molecule with the solution. The method of Tolman and Fine is then applied in the derivations of the Soret "equilibrium" and the e.m.f. of a thermocell. It is shown that the irreversible transport of heat down the temperature gradient has no effect upon the steady-state conditions, even for finite values of the gradient. A.

MECHANICS OF GASES 533

533.15

122. On the flow of gases and water vapor through wood. P. M. PFALZNER. *Canad. J. Res. A*, **28**, 389–410 (*July*, 1950).

The quantities of water vapour passing through wood have been measured under the conditions of hydrodynamic flow and of kinetic diffusion. Air and O pass through wood under hydrodynamic flow conditions in accordance with the Knudsen–Poiseuille law. Water vapour passes through wood under hydrodynamic flow conditions in much larger quantities than those predicted by the law. The rate of passage of water vapour under diffusion conditions follows the Fick diffusion law but with a diffusion coefficient that increases with relative humidity. The distinct features of the diffusion and hydrodynamic flow processes are pointed out. Porous, hygroscopic media permit the transfer of water vapour either by diffusion or by hydrodynamic flow, as determined by two distinct sets of conditions, while compact, hygroscopic media permit the transfer of water vapour by diffusion only, regardless of the external conditions. A.

533.15

123. On the differential equations of diffusion. J. D. BABBITT. *Canad. J. Res. A*, **28**, 449–74 (*Aug.*, 1950).

The fundamental bases of the differential equation of diffusion are examined. From a dynamical equation defining the motion of the gas, an equation of continuity expressing the law of conservation of mass, and an equation of state giving the relation between concentration and pressure, the differential equations are derived for the interdiffusion of two gases, for the diffusion of vapours, and for the diffusion of gases and vapours through solids. For the diffusion of gases through adsorbing solids, the dynamical equation of the flow is obtained by equating the space derivative of the spreading pressure of the adsorbed film to a resistive force equal to the product of the coefficient of resistance and the velocity of the film. The differential equations derived on this assumption agree qualitatively with measurements for the diffusion of gases through metals when the adsorption can be represented by Langmuir's equation. When the adsorption follows

the BET equation, qualitative agreement is found with the diffusion of water vapour through hygroscopic materials. It is also shown that Fick's law is not generally valid as the fundamental equation of diffusion. A.

533.15 : 533.6.013.22

124. Diffusion in a field of homogeneous turbulence. I. Eulerian analysis. G. K. BATCHELOR. *Aust. J. Sci. Res. A*, **2**, 437–50 (*Dec.*, 1949).

It is shown to be useful to distinguish between diffusion from fixed and moving centres, and only the former is considered here. The diffusion of a cloud of marked fluid particles about the average position of their centre is known when the statistical behaviour of a single fluid particle is known. Theory shows that the dispersion of a fluid particle about its initial position increases first as the square of the time of flight, t, then more slowly, and eventually increases linearly in t. Several different experiments have shown that the probability distribution of the displacement of a fluid particle is normal for all values of the time of flight. As a consequence of these two facts, it is possible to represent the diffusion by a differential equation of the heat-conduction type, with a diffusion coefficient which initially increases with t and eventually becomes constant. Some consequences of the analysis are presented. A.

533.15 : 536.24

125. Unsteady-state diffusion or heat-conduction with moving boundary. P. V. DANCKWERTS. *Trans Faraday Soc.*, **46**, 701–12 (*Sept.*, 1950).

A general method of solution is described for a class of problems in unsteady-state linear heat conduction or diffusion, which involve two phases or regions separated by a moving plane interface. The following examples are used to illustrate the method: the absorption by a liquid of a single component from a mixture of gases; tarnishing reactions; condensation of a vapour at the surface of a cold liquid or on a cooled surface; gas reacting at solid surface to form gaseous product; solution of a gas in a liquid, followed by reaction with solute; and progressive freezing of a liquid. A.

533.21

126. Pressure-volume-temperature relationships of gaseous normal hydrogen from its boiling point to room temperature and from 0–200 atmospheres. H. L. JOHNSTON AND D. WHITE. *Trans. Amer. Soc. Mech. Engrs*, **72**, 785–7 (*Aug.*, 1950).

533.21

127. Compressibility of gases at high temperatures. IV. Carbon dioxide in the temperature range 0°–600°C, and pressures up to 50 atmospheres. K. E. MACCORMACK AND W. G. SCHNEIDER. *J. Chem. Phys.*, **18**, 1269–72 (*Sept.*, 1950).

The compressibility of CO_2 has been measured in the temperature range 0°–600°C, at pressures up to 50 atm., by a method employing gas expansion. Data are presented for the virial coefficients of the series equation, PV (Amagat Units) $= A_T + B_TP + C_TP_1^2 + D_TP_1^4 + \ldots$ and values of PV (Amagat) at integral values of pressure and temperature. A.

533.275

128. A simple device for controlling relative humidity. L. A. T. BALLARD. *Aust. J. Sci.*, **11**, 76–8 (*Oct.*, 1949).

533.5

129. Vacuum tests of rubber, lead, and Teflon gaskets and vinyl acetate joints. R. W. CLOUD AND S. F. PHILP. *Rev. Sci. Instrum.*, **21**, 731–3 (*Aug.*, 1950).

Rubber, Teflon, and vinyl acetate sealed systems are compared, by an approximately quantitative method, with a lead gasket sealed system which is shown to give off negligible gas at room temperature. Rubber is shown to evolve relatively large amounts of gas with an apparent vapour pressure above a micron at room temperature and about 0·1 micron at liquid air temperature. Continuous pumping for several days produces no improvement, nor does the use of metal-to-metal joints. Vinyl acetate joints are shown to improve with pumping over a period of several days, reaching a condition exhibiting an "apparent vapour pressure" of 5×10^{-7} mm Hg, or less, at room temperature. Heating to 45°C raises the apparent vapour pressure to the 10^{-5} mm range, and heating to 100° raises the apparent vapour pressure to the micron range. A.

533.5

130. Packless valve flow regulator. W. ROSE. Note in *Rev. Sci. Instrum.*, **21**, 772–3 (*Aug.*, 1950).

533.5 : 536.453 : 621.365.4

A small high-temperature high-vacuum furnace. *See Abstr.* 258

533.6.011

131. Unsteady laminar flow of gas near an infinite flat plate. C. R. ILLINGWORTH. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 4) 603–13 (1950).

Boundary-layer equations for the unsteady flow near an effectively infinite flat plate set into motion in its own plane are subjected to von Mises's transformation. Solutions are obtained for the flows in which gravity is neglected, the Prandtl number σ is arbitrary, and the plate has a constant temperature and a velocity that is either uniform or, with dissipation neglected, non-uniform. Explicit solutions are obtained for the case in which the viscosity μ_r varies directly as the absolute temperature T_r. Solutions are also obtained for the diffusion of a plane vortex sheet in a gas, and for the boundary layer near a uniformly accelerated plate of constant temperature when gravity is not neglected. For the non-uniform motion of a heat-insulated plate, dissipation not being negligible, a solution is obtained when σ is 1 and $\mu_r \propto T_r$. The relative importance of free convection due to gravity and forced convection due to viscosity is discussed, and a solution is obtained, with $\mu_r \propto T_r$, for the free convection current set up near a plate that is at rest in a gas at a temperature different from that of the plate dissipation being neglected. A.

533.6.011

132. On the solution of differential equations of the two-dimensional steady flow of compressible fluid. O. SAITO AND A. AMEMIYA. Note in *J. Phys. Soc., Japan*, **5**, 201–2 (*May–June*, 1950).

533.6.011.3

133. The decay of axisymmetric turbulence. S. CHANDRASEKHAR. *Proc. Roy. Soc. A*, **203**, 358–64 (*Oct.* 10, 1950).

Explicit solutions, appropriate for the final period of decay, are obtained; these solutions are in agreement with Batchelor's general results on the role of the big eddies in homogeneous turbulence. It is further shown that, compatible with the equations which have been derived for axisymmetric turbulence, a state of turbulence exists which may be pictured as a superposition of two non-interacting fields which are isotropic and axisymmetric, respectively. A.

533.6.011.4

134. Hypersonic research facilities at the Ames Aeronautical Laboratory. V. I. STEVENS. *J. Appl. Phys.*, **21**, 1150–5 (*Nov.*, 1950).

Two wind tunnels recently completed—the 10- by 14-in supersonic wind tunnel and the supersonic free-flight wind tunnel—are capable of providing test Mach numbers well in excess of 5. This paper is primarily devoted to a description of these wind tunnels and their associated equipment. The treatment of the 10- by 14-in supersonic wind tunnel is concerned for the most part with the design and operation of the nozzle and diffuser which provides Mach numbers of 3·5 to about 8. Some mention is also made of the pressure measuring and flow visualization equipment. In the case of the supersonic free-flight wind tunnel high test Mach numbers are obtained by firing models at high speed into an oncoming supersonic air stream. Consequently the main emphasis is placed upon the launching techniques, the available range of test conditions, and the methods of obtaining data. A.

533.6.011.5

135. Exact solutions for flow of a perfect gas in a two-dimensional Laval nozzle. T. M. CHERRY. *Proc. Roy. Soc. A*, **203**, 551–71 (*Oct.* 25, 1950).

A family of exact solutions is found for the problem of steady irrotational isentropic shock-free transonic flow of a perfect gas through a Laval nozzle in two dimensions. The hodograph method is used, whereby the position co-ordinates x, y are expressed in terms of the velocity variables; the expressions are infinite series in the subsonic part of the flow field, infinite integrals (analytic continuations of the series) in the supersonic part. An inversion is required to get the velocity as a function of position; in general, this requires detailed numerical calculations, but approximate formulae are found for the neighbourhood of the sonic point on the axis. A.

533.6.013.22

136. The fully developed turbulent wake of a circular cylinder. A. A. TOWNSEND. *Aust. J. Sci. Res. A*, **2**, 451–68 (*Dec.*, 1949).

To account for the observed rates of transport of turbulent energy and heat, it is necessary that only part of this transport be due to bulk convection by the slow large-scale motion of the jets of turbulent fluid emitted by the central, fully turbulent core of the wake, which had been supposed previously to perform most of the transport. The remainder of the transport is carried out by the small-scale diffusive motion of the turbulent eddies within the jets, and may be described by assigning diffusion coefficients to the turbulent fluid. It is found that the diffusion coefficients for momentum and heat are approximately equal, but that for turbulent energy is considerably smaller. On the basis of these hypotheses, it is possible to calculate the form of the mean velocity distribution in good agreement with experiment, and to give a qualitative explanation of the apparently more rapid diffusion of heat. A.

533.6.08

137. Flowmeter error in measuring pulsating flow. G. W. C. TAIT. *Canad. J. Res. E.* **28**, 333–40 (*Aug.*, 1950).

Measurement of air flow with variable orifice type flowmeters in laboratory experiments revealed discrepancies that could not be explained as errors arising from faulty calibration, leaks in the system, or failure to reduce readings to standard conditions of temperature and pressure. They were found to arise because of the occurrence of rapid pulsations in the air flow. A theoretical analysis of the effect showed that these instruments indicate root mean square rather than average flow rates. The results of experiments designed to test the theory were in reasonable agreement with the predicted values. It was found that errors arising from the occurrence of pulsations could be minimized by insertion of a suitable smoothing device between the pump and flowmeter. For example, an orifice with a pressure drop of 40 cm of water reduced the flowmeter error to 5% of the true flow rate. A.

533.6.08

138. The measurement of rates of flow of gases by wet test meters. R. L. BURWELL, JR., M. METLAY AND F. W. PFOHL. *Rev. Sci. Instrum.*, **21**, 681–2 (*Aug.*, 1950).

Rates of flow of gases may be measured to an accuracy of better than 0·1% with properly modified and operated wet test meters. The period of a single rotation is measured by an electric stop clock. The instrument is not an absolute one but must be calibrated by a meter prover. A suitable prover is described. Within rather wide limits the calibration is independent of flow rate. The instrument may be used for direct measurement or for calibrating other types of flow meters. A.

533.6.08

139. On the experimental methods of the investigation of turbulent flow. I. Y. SHIGEMITSU. *J. Phys. Soc. Japan*, **5**, 157–63 (*May–June*, 1950).

A hot-wire anemometer, with time lag compensation using a negative-feedback amplifier, is used under conditions of constant resistance to measure $u'-$, $v'-$ fluctuations and $u'v'$ correlation coefficient. J. E. CAFFYN

533.6.08 : 533.6.011.6

140. Contribution to hot-wire methods. G. DÄTWYLER. *Z. angew. Math. Phys.*, **1** (*No.* 5) 298–316 (1950) *In German.*

The characteristics of hot wires are calculated approximately by using the experimental results of the heat loss of thin cylinders in a cross stream.

They are based upon the similarity law of heat transfer by forced convection. The results apply exactly only to wires of finite length as part of infinitely long wires. From King's linear equation a simple and universally valid expression for the sensitivity of hot wires is derived. King's complete equation differs from the linear one by two correction terms, one of which is neglected as small. Using a result derived from the linear equation, the complete equation and its derivative are linearized. From this corrections are derived which are rather widely valid, and which, when applied to the results obtained from the linear equation, lead to the more accurate ones corresponding to King's complete equation. The measurements necessary to obtain the data for these corrections for a given kind of wire are easily made in still air without forced heat convection. The relation between pressure and temperature which in air influence the measurements without flow are explained on the basis of experimental results in connection with the similarity law for heat transfer by free convection. The curves given include the influence of the heating circuit upon the sensitivity and the thermal lag of the hot wire. R. S. READ

VIBRATIONS . ACOUSTICS 534

534.1

141. Matrix solution for the vibration of non-uniform beams. W. T. THOMSON. *J. Appl. Mech.*, **17**, 337–9 (*Sept.*, 1950).

A matrix method for the determination of natural frequencies of any non-uniform beam is presented. It accomplishes the same task as that of Myklestad's tabular method with the added advantage of simplicity of formulation. Included is a procedure for the case where the non-uniform beam is represented by a series of uniform sections. A.

534.121.1 : 534.232 : 537.228.1

142. Piezoelectric equations of state and their application to thickness-vibration transducers. W. G. CADY. *J. Acoust. Soc. Amer.*, **22**, 579–83 (*Sept.*, 1950).

The electromechanical equations of state are written in a number of forms, extending from Voigt's formulation to the recently introduced formulation with g and h as the piezo-electric constants. Those equations that are most appropriate in the theoretical treatment of the two chief types of crystal transducer are pointed out. A detailed treatment of the thickness-vibration transducer is then given, leading to expressions for the electrical characteristics and for the acoustic vibrational amplitude and intensity. Some special cases are also considered. A.

534.121.1 : 537.228.1

143. A derivation and tabulation of the piezoelectric equations of state. J. F. HASKINS AND J. S. HICKMAN. *J. Acoust. Soc. Amer.*, **22**, 584–8 (*Sept.*, 1950).

The linear piezo-electric equations of state with strain, electric displacement, and entropy, as independent variables, are derived from the principle of conservation of energy. These 13 tensor equations are then specialized to the adiabatic case and used as the starting point for the development of all possible linear piezo-electric equations of state using in turn as independent variables, stress and electric field, strain and polarization, and stress and polarization. This process gives as a by-product the set of relations among the elastic, electric and piezo-electric coefficients for the various pairs of independent parameters and emphasizes the frequently overlooked fact that the piezo-electric equations of state are mutually convertible. M.k.s. units and the I.R.E. notation are used throughout the discussion and a table is given which compares the I.R.E. notation with the former notations of Cady and Mason. A.

534.154 : 621.317.39

144. An electronic vibration meter. E. F. CAROME. *Trans Amer. Geophys. Un.*, **31**, 529–30 (*Aug.*, 1950).

A completely portable electronic instrument which appears to have wide application in the field of vibration measurements has been developed. The circuit is such that a meter responds to the maximum amplitude of a transient or continuous voltage input. The indication is held for an indefinite time. Used in conjunction with a commercial vibration pickup, this instrument provides a simple and convenient means of measuring accelerations in structures and of referring them to a standard index of damage. A.

534.21

145. Propagation of sound in rarefied helium. M. GREENSPAN. *J. Acoust. Soc. Amer.*, **22**, 568–71 (*Sept.*, 1950).

The velocity and attenuation of sound at 1 mc/sec were measured in He at pressures as low as 0·1 mm Hg (sound frequency about twice mean collision rate). The observed dispersions are very large and agree well with those predicted by existing theories except at very low pressures where uncertainties are introduced by lack of gas purity. A.

534.21 : 534.321.9

146. On the theory of supersonic absorption. A. GIERER AND K. WIRTZ. Letter in *Phys. Rev.*, **79**, 906–7 (*Sept.* 1, 1950).

534.213.4

147. On the propagation of sound waves in a cylindrical conduit. F. B. DANIELS. *J. Acoust. Soc. Amer.*, **22**, 563–4 (*Sept.*, 1950).

The characteristic impedance and propagation constant of a cylindrical conduit are calculated on the basis of an equivalent electrical T-section. Numerical values of the results are plotted for air at 20°C, for a range of values of the independent variable which includes the region of transition from isothermal to adiabatic conditions. A.

534.213.4

148. Attenuation of $(n, 0)$ transverse mode in a rectangular tube. R. E. BEATTY, JR. Letter in *J. Acoust. Soc. Amer.*, **22**, 639 (*Sept.*, 1950).

534.222

149. Velocity considerations in pulse propagation. T. D. NORTHWOOD AND D. V. ANDERSON. Letter in *J. Acoust. Soc. Amer.*, **22**, 513–14 (*July*, 1950).

A discussion of group velocity.

534.222.2

150. The propagation of spherical blast. G. B. WHITHAM. *Proc. Roy. Soc. A*, **203**, 571–81 (*Oct.* 24, 1950).

The attenuation of spherical shocks at large distances from the origin is investigated mathematically. To do this a general theory is developed of spherical wave motion at large distances, where the linearized approximations of the theory of sound are valueless owing to the divergence of the characteristics at infinity. In the case of disturbances small from the outset, this general theory is used to modify the linearized approximation to give a theory which is uniformly valid at all distances from the origin. For a weak explosion, a modified linear theory is used to show that behind the front shock an envelope of characteristics is formed and hence a second shock must appear. A.

534.222.2

151. Shock waves and the propagation of finite pulses in fluids. W. G. PENNEY AND H. H. PIKE. *Rep. Phys. Soc. Progr. Phys.*, **13**, 46–82 (1950).

This paper is a review of theoretical work, much of it being unpublished and contained in several Ministry of Home Security reports. Shock-wave relationships are considered and the refraction, reflection and diffraction of plane shock waves are discussed. L. S. GODDARD

534.231.3

152. A method for measuring source impedance and tube attenuation. J. E. WHITE. *J. Acoust. Soc. Amer.*, **22**, 565–7 (*Sept.*, 1950).

If the active face, or acoustic output terminal, of a sinusoidal sound source moves as a plane piston, then the source can be characterized by a blocked pressure and an acoustic output impedance. If this piston is coupled to a microphone by means of a closed air column, the pressure at the microphone depends on the acoustic impedance of the microphone, on the impedance of the source, and on the air column. An expression for this pressure as a function of the length of the air column is developed, and data are presented which show how source impedance, tube attenuation and other quantities may be obtained. A.

534.232

153. Response peaks in finite horns. C. T. MOLLOY. *J. Acoust, Soc. Amer.*, **22**, 551–5 (*Sept.*, 1950).

In this paper the term hyperbolic horn is used to designate those horns whose area law is given by: $S(x) = \pi R_0^2[\cosh ax + T \sinh ax]^2$, where $S(x)$ is the cross-sectional area of the horn at distance (x) from the throat, (a) is the flare constant; (T) is the shape parameter and (R_0) is the throat radius. The pressure on the axis due to a circular mouth, unbaffled horn loudspeaker is derived, using the recent results of Levine and Schwinger [Abstr. 1181 (1948)] and some useful additional functions are computed from their data and presented here in graphical form. Calculation of the frequencies at which peaks occur in hyperbolic horn type loudspeaker frequency response curves and of the parameters of hyperbolic and exponential horn type loudspeakers having predetermined peaks in their frequency response curves are shown. A.

534.232

154. Resonance characteristics of a finite catenoidal horn. G. J. THIESSEN. *J. Acoust. Soc. Amer.*, **22**, 558–62 (*Sept.*, 1950).

Expressions for the impedance components of a finite catenoidal horn are derived and a comparison with similar exponential and conical horns made. The impedance of a section of a catenoidal horn is also calculated and it is shown how, for the finite as well as the infinite horn, this approaches that of the exponential as more length is trimmed from the throat end. The assumption that the resonance characteristics of a horn are the same as that of a uniform tube, provided the higher velocity of sound for the horn is used, seems to be borne out for the catenoidal horn but for the exponential horn the agreement is not very good except at higher frequencies. A.

534.232

155. The sound field of a Straubel *X*-cut crystal. E. W. SAMUEL AND R. S. SHANKLAND. *J. Acoust. Soc. Amer.*, **22**, 589–92 (*Sept.*, 1950).

The sound beam generated in a liquid by a 7·5 megacycle Straubel *X*-cut quartz crystal has been investigated by the phenomenon of streaming. The streaming patterns in CCl_4 have been determined by measuring the velocities of sugar particles which have very nearly the same density as the liquid. The velocity distributions produced by a cylindrical sound beam in liquid contained in a concentric cylindrical tank are found to be in good agreement with those predicted by Eckart's solution of the hydrodynamical flow equations. Comparison measurements with square *X*-cut quartz crystals of the same frequency give poor agreement with theory. Since Eckart's analysis assumes uniform sound intensity across the beam, these experiments indicate that the sound beam radiated by a Straubel cut crystal is very uniform. A.

534.232 : 537.228.2

156. The production of ultrasonic waves by electrostriction. H. H. RUST. *Z. angew. Phys.*, **2** (*No.* 7) 293–4 (1950) *In German.*

Falkenhagen described a method of producing ultrasonic waves by electrostriction [Abstr. 100 (1950)]. The method is discussed in detail and comparisons are made between it and the technique described 30 years ago by Langevin. A. C. WHIFFIN

534.232 : 621.395.61

157. A second-order gradient noise canceling microphone using a single diaphragm. W. A. BEAVERSON AND A. M. WIGGINS. *J. Acoust. Soc. Amer.*, **22**, 592–601 (*Sept.*, 1950).

A close-talking, noise-cancelling microphone has been developed which responds to the 2nd order of the pressure gradient and which has only one diaphragm. Since there are 4 sound pressures involved in a 2nd-order gradient microphone it has been deemed necessary in the past to have 4 surfaces for the 4 pressures to act upon. This microphone has sound entrances to the two surfaces of a single diaphragm spaced and oriented in such a manner as to produce the 2nd-order effect, thereby increasing

the signal-to-noise ratio over that obtained in a 1st-order gradient microphone. Mathematical analyses are made of the microphone first as a purely theoretical microphone with infinitesimal spacing of the sound entrances, then as a microphone with dimensions between sound entrances which are practical for use in a microphone of this type. A.

534.24

158. On the non-specular reflection of plane waves of sound. V. Twersky. *J. Acoust. Soc. Amer.*, **22**, 539–46 (*Sept.*, 1950).

Scattered reflection by various rigid, non-absorbent, non-porous surfaces composed of either semi-cylindrical or hemispherical bosses (protuberances) on an infinite plane is analysed. Exact solutions for the problem of the single boss and a plane wave at an arbitrary angle of incidence are derived through consideration of a cylinder or sphere and two simultaneously incident "image waves." Finite patterned distributions of such bosses are then treated and the far field solution obtained subject to the restriction that the secondary excitations of the various bosses be neglected. A.

534.32

159. On the influence of nonlinear distortion on the audibility of mistuned musical intervals. W. Weitbrecht. *Fernmeldetech. Z.* [*FTZ*] **9**, 336–45 (*Sept.*, 1950) *In German.*

Experiments are described to determine the audibility of slightly mistuned musical intervals (octave, fifth, fourth, major and minor third, minor sixth between 523 and 1 046 c/sec) as affected by the presence, or otherwise, of higher overtones. The extent of the mistuning Δf is in the range 0 to 3 or 4 cycles/second. A series of experimental curves are shown indicating the audible limits (phons) for various mistunings as a function of the "Klirrfaktor." This latter is defined as the ratio of the effective value of the sum of all overtones to the effective value of the total range. A. B. WOOD

534.321.9

160. Method of making ultrasonic waves visible. H. Schreiber and W. Degner. *Naturwissenschaften*, **37** (*No.* 15) 358–9 (1950) *In German.*

After a brief résumé of the methods so far employed in making ultrasonic waves optically visible, details are given of a technique developed for use in technical and biological work. A ZnS/CdS phosphor is used, of unknown phosphor content, and after exposure to light for times between 30 sec and 5 min, the resulting phosphorescence is extinguished at the areas of maximum absorption of ultrasonic energy. Using a quartz transmitter of 1·56 Mc/s, satisfactory photographs of the phenomenon were obtained at quartz-phosphor distances of between 0·4 and 11 cm.

A. C. WHIFFIN

534.321.9 : 535.42

Diffraction of light by ultrasonic waves. *See Abstr.* 234

534.321.9 : 537.228.1

Piezoelectric crystals and their application to ultrasonics. *See Abstr.* 302

534.321.9 : 669

161. Ultrasonic soldering of aluminium. B. E. Noltingk and E. A. Neppiras. Letter in *Nature, Lond.*, **166**, 615 (*Oct.* 7, 1950).

534.374

162. Mathematical analysis of an acoustic filter. N. Olson. *Canad. J. Res. A*, **28**, 377–88 (*July*, 1950).

Equations have been derived for the frequency limits of the attenuation bands, the degree of attenuation, and the phase change of a specific type of filter which cannot be readily analysed by the side branch method. The characteristics have been verified by measurements on experimental filters. A.

534.612

163. Measurement of ultrasonic fields in fluids. R. Krause. *Z. angew. Phys.*, **2** (*No.* 9) 370–3 (1950) *In German.*

Apparatus capable of measuring accurately the pressure distribution in fluids at frequencies of 1 Mc/s is described. Results are given for water and the importance of the damping of the source is illustrated. Agreement between the calculated and observed results leads to the conclusion that the vibration of the elements of the quartz radiator are in phase.

H. J. H. STARKS

534.613

164. On the theory of acoustic radiation pressure. J. S. Mendousse. *Proc. Amer. Acad. Arts Sci.*, **78**, 148–64 (*April*, 1950).

This is an attempt toward a comprehensive and rigorous treatment in the case of non-viscous motions. The accuracy of the usual approximation methods of computation depends on the "amplitude" of the motion and a rigorous definition of the amplitude of a whole motion, in contrast to the amplitude of vibration at a particular point is first given. From there on the 1st- and 2nd-order terms in the series expansion of the acoustic radiation pressure, and other quantities, with respect to the amplitude are rigorously derived. The development of the theory brings out a remarkable mass-energy relation: defining the equilibrium of a volume V of the fluid by the average position of its boundaries (with respect to time), the difference $(\bar{E}_p - \bar{E}_k)$ of the potential and kinetic energies inside this volume V is equal to $\frac{1}{2}mc^2$, where c is the wave velocity and m the time-average increase of mass caused by the motion inside the volume V. Finally, a formula is obtained for the radiation pressure on the walls of a container which participates in the oscillations of the fluid. A.

534.614

165. Propagation of low frequency ultrasonic waves in rubbers and rubber-like polymers. P. Hatfield. *Brit. J. Appl. Phys.*, **1**, 232–6 (*Oct.*, 1950).

The experiments cover the frequency range of 50 to 350 kc/s and a temperature range 0–60°C. It is found that the velocity varies from $1{\cdot}1\times10^5$ to $1{\cdot}8\times10^5$ cm/sec at room temperatures and the absorption varies from less than 0·1 to 2 db/cm at 50 kc/s frequency and from 0·7 to 11 db/cm at 350 kc/s in different rubbers. The applications of these materials as lenses for focusing and media suitable for the transmission of ultrasonic waves are discussed, along with calorimetry. A.

534.78

166. Uniform speech-peak clipping in a uniform signal-to-noise spectrum ratio. D. W. MARTIN. *J. Acoust. Amer. Soc.*, **22**, 614–21 (*Sept.*, 1950).

(Uniform here is with respect to frequency.) A graphical function $W(r, c)$ has been determined experimentally, in which W is word articulation, r is the relative level of unclipped speech and the noise, and c is the amount of uniform, symmetrical, speech-peak clipping. Pre-emphasis of the speech signal gave an approximately uniform-speech spectrum prior to clipping. Uniform, random noise was mixed with the clipped speech before postequalization, making the final noise spectrum similar in shape to the speech spectrum. The real-ear response of the earphones was compensated electrically to yield a uniform orthotelephonic response for the communication system, in the frequency range contributing significantly to articulation index. For constant clipping c_n the function $W(r, c_n)$ approaches $W(r, 0)$ as a limit for sufficiently large values of r. For $c < r + 5$, $W \doteqdot W(r, 0)$. For the case of no clipping, $W(r)$ when transformed to $W(A)$ (A being articulation index) resembles closely the curve by Pollack. A.

534.843

167. On the acoustics of coupled rooms. C. M. HARRIS AND H. FESHBACH. *J. Acoust. Soc. Amer.*, **22**, 572–8 (*Sept.*, 1950).

Approaches the problem of coupled rooms from the "wave" point of view, treating the coupled rooms as a boundary value problem in obtaining an approximate solution. The results explain some discrepancies noted by earlier researchers between experiment and predictions from geometrical acoustics; for example, the dependence of absorption in a room on the position of the open area which couples the room to an adjacent one. For the case where the window area which couples one room to another is comparable in size with the partition which separates the rooms, the effect of the partition will be least when it is at a particle-velocity node. Where the window area is small compared with the partition which separates the two rooms, the effect of the coupling window depends on the square of the unperturbed pressure at the window. A.

534.845

168. Absorption of sound by porous materials. C. ZWIKKER. *Research, Lond.*, **3**, 400–7 (*Sept.*, 1950).

Theoretical consideration is given of the mechanism involved, for the case of sound waves which impinge normally on a wall of infinite dimensions. Expressions are obtained which enable the wave impedance and propagation constant of absorbing materials to be determined experimentally and their connection with sound absorption is discussed. The absorbing action of circular pores is considered, showing how a material is characterized by its porosity, specific flow resistance, structure factor and thickness. Brief treatment is given of the behaviour of rubber-like skeletons where vibrations in the solid frame itself are important.

G. F. HODSMAN

534.851 : 621.395.625

169. Modern tendencies in material for recording on discs. P. GILOTAUX. *Onde Elect.*, **30**, 301–8 (*July*, 1950) *In French.*

The processes for producing matrices from wax or lacquer recordings and the subsequent manufacturing of discs are outlined and compared. The standard recording frequency characteristic is stated and the resulting response from magnetic, etc., pick-ups compared with that obtained from a crystal pick-up. Next, the various contributing factors in the generation of surface noise and the two forms of distortion, pinch and contacts effects, are studied with regard to both lacquer and vinylite discs. Similarly, such qualities affecting the discs as wear in needles and resonances in pick-ups are discussed. The Columbia and R.C.A. microgroove recording systems are discussed and compared. The probable restriction of these systems to certain limited applications is predicted.

H. G. M. SPRATT (R)

OPTICS . RADIATION . SPECTRA 535

535.214.6

170. Photophoresis and a property of solar light producing a rotation of matter in a vacuum. F. EHRENHAFT AND E. REEYER. *C.R. Acad. Sci., Paris*, **231**, 541–3 (*Sept.* 11, 1950) *In French.*

Gives 5 photographs of the trajectories of small particles in air and A at pressures ~ 2 mm Hg. In all cases the particle moves along a helix, whether the light is from the sun or from an arc lamp.

N. CORCORAN

535.214.6

171. Photophoresis, and the pressure exerted by light on matter in a vacuum. F. EHRENHAFT AND E. REEGER. *Acta Phys. Austriaca*, **4** (*No.* 1) 118–24 (1950) *In German.*

The motion of small particles in a vacuum under electromagnetic radiation and steady electric and magnetic fields is not in general in agreement with classical electrodynamics. The phenomena becomes more marked as the pressure is reduced, showing that they are not due to the atmosphere. They may be explained by supposing that graphite particles of 10^{-3} cm diam. are subjected to a rotatory force when strongly illuminated; this force is in addition to the Lebedew pressure.

N. CORCORAN

535.245 : 628.972

172. Interflections in coupled enclosures. P. MOON AND D. E. SPENCER. *J. Franklin Inst.*, **250**, 151–66 (*Aug.*, 1950).

A mathematical treatment of the light distribution in two opaque enclosures with adjacent congruent openings separated by a sheet of translucent material. The generalized solution is, by a series of simplifying assumptions, made applicable to a room with louverall ceiling and the way in which the coefficient of utilization in such a room can be calculated is indicated by specific examples.

J. W. T. WALSH (R)

535.317.9 : 535.81

173. Development of an aspheric lens surface. H. C. SCHEPLER. *Amer. J. Phys.*, **18**, 385–7 (*Sept.*, 1950).

A graphical method is given for drawing the

aspheric (hyperbolic) surface giving freedom from spherical aberration in a plano-convex lens of any focal length and refractive index. A mechanical linkage enables this surface to be turned on a lathe from plastic material. R. W. FISH

535.319

174. Lens tester for photographic lenses. F. G. BACK. *Rev. Sci. Instrum.*, **21**, 722–4 (*Aug.*, 1950).

Basically a modified autocollimator with a built-in colour filter arranged in conjunction with an assembly unit consisting of an adjustable microscreen and a lens holder. This latter unit may be rotated about an axis perpendicular to the optical axis of the instrument, giving an immediate reading of the tangential and sagittal foci. By means of this instrument it is possible to determine: (1) the flange focal distance, (2) the shift of axial focus with respect to the lens aperture, (3) longitudinal chromatic aberration, (4) tangential and sagittal foci for any angular distance from the axis and for any aperture, and (5) all these readings for various colour bands. This new instrument makes possible the immediate reading of the results without further computation. The determination of the nodal point and the focal length for extra-axial aberrations is unnecessary. Built-in colour filters allow testing for chromatic aberrations. Because of a special microscreen and reflection-free beam splitter arrangement, this instrument gives satisfactory readings also for small apertures. A.

535.323

175. Refractive index of silver chloride for visible and infra-red radiant energy. L. W. TILTON, E. K. PLYLER AND R. E. STEPHENS. *J. Opt. Soc. Amer.*, **40**, 540–3 (*Aug.*, 1950).

The refractive indices of a 31° prism of AgCl were measured at 30 wavelengths at a constant room temperature of 23·9°C, from 0·578 to 20·6 μ by use of a minimum-deviation spectrometer and a Perkin–Elmer i.r. spectrometer equipped with a calibrated screw for operation of the Littrow mirror. A Cd–Hg lamp was the source from 1 to 2 μ. From 2 to 20 μ a Globar was used as the source with various Baird's reflection interference filters and the absorption bands of CO_2, CS_2, water, methylcyclohexane, polystyrene, trichlorobenzene, and chlorobenzotrifluoride for the identification of wave-lengths. In the visible region two prisms, one pressed and polished, the other sawed and lapped, were used and the results compared. The sensitivity of index to temperature is approximately $-6{\cdot}1\times10^{-5}$ per centigrade degree for wavelength 0·610 μ. A.

535.33

176. Practical spectroscopy. G. R. HARRISON, R. C. LORD AND J. R. LOOFBOUROW. *London, Blackie and Son; New York, Prentice-Hall* (1950) 605 *pp.*

A text and reference book of experimental spectroscopy written by a physicist, a chemist, and a biophysicist, of value to all who use spectroscopic techniques. It comprises chapters on selection of spectroscopic instruments (i.e. prisms, gratings, the focusing and observing systems, and illuminators); the testing, adjustment and care of spectroscopic equipment; illumination of the spectroscope; photography of the spectrum; light sources for spectroscopy (i.e. thermal emission sources, open and enclosed arcs, discharge tubes, electric sparks, etc.); identification of spectrum lines; and two chapters on the theory of atomic and molecular spectra. It describes the technique of photometry: radiometric, photoelectric, and photographic; absorption spectrophotometry, qualitative and quantitative spectrochemical analysis; infrared, Raman, and ultra-violet spectroscopy; and interferometric spectroscopy. It has a great number of plates, diagrams and tables, and a bibliography at the end of each chapter. A list is given of manufacturers (mostly American) of spectroscopic apparatus. Many references are given throughout the text. C. EMMERING

535.33.071–15

177. A ratio-recording double-beam infra-red spectrophotometer with automatic slit-control. D. F. HORNIG, G. E. HYDE AND W. A. ADCOCK. *J. Opt. Soc. Amer.*, **40**, 497–503 (*Aug.*, 1950).

A scheme for converting any spectrometer to a direct ratio-recording spectrophotometer is described. The optics consist of a double-beam "slit illuminator" which passes light from a common source area alternately over 2 identical paths to the spectrometer entrance slit. The optical arrangement allows great flexibility in the use of samples since it includes foci for small samples and sufficient space for low temperature cells, gas cells, etc. Common paths make the use of filters, polarizers, etc., convenient and accurate. Spectrometer optics, detector and amplifier are common to both signals and hence non-critical. The electrical signals from the 2 beams are amplified, "sorted" and rectified by synchronous switches, compared potentiometrically and their ratio recorded. Details of the amplifier and ratio circuits are included. A simple method is described by which errors in the ratio caused by the frequency characteristics of the dectector, input transformer, or amplifier are eliminated. The energy in the comparison beam is kept constant at any predetermined level while a spectrum is scanned by means of a simple serve slit-width control. This arrangement is much more convenient and flexible than cams, particularly when interchangeable prisms are used. A.

535.33.071–15

178. Double beam percentage recording infra-red spectrometer. G. J. MINKOFF. *Fuel*, **29**, 228–32 (*Oct.*, 1950).

The instrument, which is based on a monochromator, and has both NaCl and KBr optics, is completely automatic in use, and is specially designed so that it can be used for studies of gas-phase oxidations and combustion reactions, as well as for conventional analytical purposes. Mention is made of some of the researches now in progress with this instrument, including studies of the absorption spectra of organic peroxides. A.

535.33.071–15 : 535.822

179. An infra-red microspectrometer for biological research. D. L. WOOD. *Rev. Sci. Instrum.*, **21**, 764–6 (*Aug.*, 1950).

A totally reflecting microscope of numerical aperture 0·6 coupled with a Perkin–Elmer Model 12C infrared prism spectrometer. The combination

makes possible the recording of infrared spectra of individual cells of biological materials over the familiar range from 1 to 15 μ, and has been particularly designed for the study of muscle fibres. The techniques for producing aspheric optics used in the microscope are discussed. A.

535.338.3

180. Analysis of the spectrum of doubly ionized thorium, Th III. P. F. A. KLINKENBERG. *Physica*, **16**, 618–50 (*July–Aug.*, 1950).

The analysis is revised and extended to include 314 lines as transitions between 39 even and 40 odd levels arranged in two term systems. All configurations are completed. Poorly combining levels are supported by theoretical computations, using quantum-mechanical formulae valid for single configurations; closer agreement is obtained by Racah, who treated configuration interactions and communicated his results to the author. A complete list of all observed lines attributed to Th III is given. A new group of Th III-lines, discovered in the ultraviolet region below 3 300 Å, are considered as combinations of unknown high levels with the intermediate configurations, this interpretation being consistent with the ionization potential value provisionally determined at 161 000 cm^{-1} or 19·9 V. A.

535.338.3

181. On the spectrum of Th III. G. RACAH. *Physica*, **16**, 651–66 (*July–Aug.*, 1950).

The levels of Th III are compared with the theoretical formulae for intermediate coupling with configuration interaction. The agreement is very satisfactory. Also the calculated g-values generally agree with the experimental data. A.

535.338.332

182. Study of the variation of the factor of reflection of mercury vapour as a function of the pressure for two of the hyperfine components of the resonance ray $\lambda = 2\,537$. J.-L. COJAN. *C.R. Acad. Sci., Paris*, **231**, 337–9 (*July* 31, 1950) *In French.*

Continuing earlier work [Abstr. 6884 (1949)] the reflection factors are shown graphically. The theoretical discussion is to be given later, but it is pointed out that for pressures below 1 cm the reflection factor varies as p^2, whereas above about 5 cm the reflection factor is proportional to p.

A. HARVEY

535.338.333 : 539.155.2

183. Hyperfine structure and isotope shift in barium. O. H. ARROE. *Phys. Rev.*, **79**, 836–8 (*Sept.* 1, 1950).

Spectroscopic hyperfine structure studies with separated isotopes of Ba have definitely confirmed a nuclear spin $\frac{3}{2}$ for the odd isotopes Ba^{135} and Ba^{137}. The lines of the even isotopes show no structure. The isotope shift is linear among masses of the same parity, but there is a relatively great odd-even shift: note the order 138, 136, 134, 137, 135 in Ba I, and 138, 136, 137, 134, 135 in Ba II. A.

535.338.4

184. The presumed $^1\Sigma^-$-term in AlH. B. KLEMAN, Å. LAGERCRANTZ AND U. UHLER. *Ark. Fys.*, **2**, *Paper* 34, 359 (1950).

535.338.4

185. Theoretical computations of transition probabilities for electronic spectra of C_2 and N_2^+. H. SHULL. *Astrophys. J.*, **112**, 352–60 (*Sept.*, 1950).

The oscillator strengths for the transitions $^3\Pi_g \leftrightarrow {}^3\Pi_u$ (Swan bands) and $^1\Pi_g \leftrightarrow {}^1\Pi_u$ of C_2 and $^2\Sigma_u^+ \leftrightarrow {}^2\Sigma_g^+$ first negative bands) of N_2^+ are computed. The transitions are treated as one-electron transitions $x\sigma_g \leftrightarrow y\sigma_u$, in which the MO's are taken as linear combinations of AO's of either the Slater form or the self-consistent field functions fitted by exponentials of the Slater form. The f-numbers are computed as a function of the atomic orbital form and as a function of hybridization of $2s$ and $2p\sigma$ orbitals. The oscillator strengths are found to be insensitive to the forms used for the AO's but relatively sensitive to hybridization in the region of low hybridization. The most probable f-number for the C_2 Swan bands is considered to be 0·13. This value is considerably higher than those used previously in astronomical calculations. A.

535.338.4

186. The identification of molecular spectra. R. W. B. PEARSE AND A. G. GAYDON. *2nd edition, revised. Chapman and Hall, London* (1950), 276 *pp.*

About 1 800 persistent band heads in the region 2 000 to 10 000 Å are listed in order of wavelength, with brief indications of intensity, appearance and sources. This table is followed by more detailed tables and descriptions for spectra of individual molecules, arranged alphabetically. As well as diatomic molecules, a selection of band systems of the more important polyatomic molecules is included. The 12 plates show 65 strips of important band systems and some common comparison spectra. Substantial alterations and a 25% expansion have been made in the revised edition. A. G. GAYDON

535.338.4 : 551.593.9 : 539.132

Anomalous molecular rotation in low-pressure O_2 bands. *See Abstr.* 532

535.338.42

187. Perturbations in the band-spectrum of the sulphur molecule. S. M. NAUDÉ AND H. VERLEGER. *Z. Phys.*, **128** (*No.* 2) 173–9 (1950) *In German.*

From a study of the spin-splitting in the $^3\Sigma_u^- - {}^3\Sigma_g^-$ system of S_2 it is concluded that the upper state vibrational levels with $v' = 1, 3$ and 5 are unperturbed, while levels with $v' = 2, 4, 6$ and 7 are perturbed. No rotational perturbations have been detected.

R. F. BARROW

535.338.42

188. The band-spectrum of barium oxide. A. LAGERQVIST, E. LIND AND R. F. BARROW. *Proc. Phys. Soc., Lond. A*, **63**, 1132–55 (*Oct.*, 1950).

The band-spectrum of BaO between 5 000 and 7 000 Å, which consists of a single $^1\Sigma$–$^1\Sigma$ system, has been the subject of a new rotational analysis in which the following bands have been examined: 5,0, 4,0, 3,0, 3,1, 2,0, 2,1, 1,1, 1,2, 0,2, 0,3 and 0,4. In the upper state some 16 perturbations have been found. They appear to arise from interactions with at least 4 electronic states or substates. Fairly complete information about one of the perturbing levels has been obtained. A.

535.338.42

189. Band-spectrum of ZrO. M. Afaf. *Proc. Phys. Soc., Lond. A*, **63**, 1156–70 (*Oct.*, 1950).

The spectrum of ZrO has been photographed in the u.v., the visible and the i.r., from arcs running under special conditions. This has made possible the identification of 3 new systems in the u.v., as well as 2 less conspicuous ones in the i.r. It has also made it possible to extend the blue system α of ZrO. A.

535.343–15

190. Recent investigations in the far infra-red. T. K. McCubbin, Jr. and W. M. Sinton. *J. Opt. Soc. Amer.*, **40**, 537–9 (*Aug.*, 1950).

Experiments have been carried out in the far i.r. region from 100 to 600 microns using a grating spectrograph with crystal quartz optics. These experiments include measurement of the transmission of the atmosphere for paths up to 8 m, the measurement of the transmission of various solid substances, and the observation of the longest wavelength pure rotation lines in the spectra of NH_3 and HCl. A.

535.343.2

191. Absorption spectra of the sodium peruranates. T. V. Arden and P. McGlone. Letter in *Nature, Lond.*, **166**, 560–1 (*Sept.* 30, 1950).

535.343.2

192. The absorption spectra of solid lead sulphide, selenide and telluride. A. F. Gibson. *Proc. Phys. Soc., Lond. B*, **63**, 756–67 (*Oct.*, 1950).

Recent interest in PbS, PbSe and PbTe as photoconductors makes information on their absorption spectra valuable. It is found that the absorption spectrum of each material is characterized by strong absorption in the visible and u.v. region, with a further band in the i.r. The effects of temperature and oxidation are also studied. In PbS the forbidden energy region between the filled and empty bands is found to be about 1·3 eV in width, not 0·4 eV as previously suggested. Hence photoconductivity in PbS cannot be associated with the main lattice. The corresponding energy gaps in PbSe and PbTe are found to be about 1·05 eV and 0·9 eV respectively. A.

535.343.2 : 535.372 : 536.48

193. A new method of investigating the absorption and luminescence of micro-objects at low temperatures. Z. M. Sverdlov. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 4) 543–6 (1949).

535.343.2 : 548.0

194. Absorption spectra of colored potassium chloride containing several kinds of impurities. S. Kondo and T. Suita. Note in *J. Phys. Soc., Japan*, **5**, 200–1 (*May–June*, 1950).

535.343.2–14 : 539.181

195. The radiofrequency spectrum of $K^{39}F$ by the electric resonance method. L. Grabner and V. Hughes. *Phys. Rev.*, **79**, 819–28 (*Sept.* 1, 1950).

Linear polar diatomic molecules in one, or at most two, rotational states and definite states of space quantization are selected by means of inhomogeneous electric fields. The molecular transitions are not of the ΔJ type (between different rotational states), rather between states with the same value of J but different values of m_J, the electric quantum number characterizing the state of space quantization. Lines are observed as a change in intensity of the refocused beam when the frequency of an oscillating field, which is perpendicular to an homogeneous field, times Planck's constant is equal to the energy difference between different states of space quantization. The frequency of the rotational Stark line is determined by the value of the homogeneous static field. The Stark line was observed at low and high fields for $J = 1$ and low fields for $J = 2$. It is found to be split. The fine structure is due to an interaction of the nuclear electric quadrupole moment of the K^{39} nucleus with the rest of the charges of the molecule as well as a variation of $\mu^2 A$ with the vibrational state of the molecule (μ permanent electric dipole moment, A moment of inertia). In addition, the quadrupole interaction constant is found to vary with the vibrational state. The frequency dependence of the Stark line at strong fields permits the determination of μ and A; they were determined only for the zeroth vibrational state. A.

535.343.2–15 : 548.0

196. Motions of molecules in condensed systems. VII. The infra-red spectra for single crystals of ammonium nitrate and thallous nitrate in polarized radiation. R. Newman and R. S. Halford. *J. Chem. Phys.*, **18**, 1276–90 (*Sept.*, 1950).

The selection of proper orientations for this work is indicated for crystals in general and potential difficulties with some types are noted. Spectra for the first two crystals show (1) that absorptions by molecular modes of nitrate ion, and their combinations, are strongly polarized in directions predicted for these structures by the general theory of crystalline spectra; (2) that envelope structure resulting from combinations between molecular modes and lattice modes is present but not uniquely polarized, again in agreement with the general theory; (3) that absorptions by molecular modes of ammonium ion appear to be unpolarized, indicating that these ions are disordered from rotation or other causes. Spectra for the third substance are used to complete the determination of its crystal structure. One band in this substance has a remarkable envelope consisting of a strongly polarized central branch and, at room temperature, three pairs of symmetrically distributed, virtually unpolarized satellites. The satellites become more numerous at lower temperature. The spectra for the several substances suggest that optical branches of their lattice mode distributions are located between about 35 and perhaps 200 cm^{-1}. A.

535.343.2–15 : 548.0

197. Motions of molecules in condensed systems. VIII. Infra-red spectra for ammonium nitrate, thallous nitrate, and plumbous nitrate at − 160° and 25°C. R. Newman and R. S. Halford. *J. Chem. Phys.*, **18**, 1291–4 (*Sept.*, 1950).

Envelope structure in the spectra of these substances is shown to depend upon temperature in a way that indicates the presence of both additive and subtractive combinations of lattice modes with molecular modes. At − 160°c there are no less than 7 distinct satellites on the high frequency side of one band in $TlNO_3$ with damped out counterparts on the low-frequency side. The possibility is considered that a 2nd-order phase transition, as well as a 1st-

order one, may be influencing envelope structure in NH_4NO_3. The spectra for $Pb(NO_3)_2$ contain several features of interest. A.

535.343.3–15

198. Infra-red spectra of condensed oxygen and nitrogen. A. L. Smith, W. E. Keller and H. L. Johnston. Letter in *Phys. Rev.*, **79**, 728 (*Aug.* 15, 1950).

535.343.3/.4–14

199. Absorption of microwaves in gases and liquids. G. Klages. *Experientia*, **6** (*No.* 9) 321–9 (1950) *In German.* A general review. D. H. Whiffen

535.343.4

200. Contribution to the spectroscopic study of the molecule NO. P. Migeotte and B. Rosen. *Bull. Soc. Roy. Sci., Liége*, **19** (*No.* 6–7) 343–8 (*June–July*, 1950) *In French.*

Results obtained from work on the far ultra-violet absorption spectrum are compared with those of Tanaka [*Sci. Pap. Inst. Phys. Chem. Res., Tokyo*, **43**, 28 (1948)]. R. F. Barrow

535.343.4

201. Infra-red and ultraviolet spectra of sulphur monoxide. A. V. Jones. *J. Chem. Phys.*, **18**, 1263–8 (*Sept.*, 1950).

The i.r. spectrum of SO, prepared by the method of Schenk, has been examined between 400 cm^{-1} and 2 000 cm^{-1}. Bands were observed at 679 cm^{-1} and 1 165 cm^{-1}. The u.v. absorption band system discovered by Schenk in the region 3 500 Å to 2 500 Å has been obtained under high resolution (21-ft grating). A very sharp predissociation occurs at 31 702 cm^{-1} leading to an upper value for a dissociation limit of 91 kcal. $mole^{-1}$. A ground state vibration frequency of 679 cm^{-1} was deduced from a partial analysis of the electronic absorption band system. It has been shown that the molecule cannot be diatomic SO, but probably has the formula S_2O_2, as suggested by Kondrat'eva and Kondrat'ev. A.

535.343.4–14

202. The fine structure of the microwave absorption spectrum of oxygen. J. H. Burkhalter, R. S. Anderson, W. V. Smith and W. Gordy. *Phys. Rev.*, **79**, 651–5 (*Aug.* 15, 1950).

By means of a Zeeman modulation microwave spectrometer used with a lock-in amplifier, the 5 mm wave absorption lines of O have been measured at low pressures, where they are completely resolved. Precise measurements of the frequencies of the lines have been made, and uniform deviations from the frequencies predicted by the theoretical formulas of Schlapp were found. The pressure variation of line-width has been measured for 3 of the observed lines, and found to be linear. The line-width parameter was found to vary with the rotational state. It is 0·053 cm^{-1}/atmos. for $K = 3$, and 0·021 cm^{-1}/atmos. for $K = 21$. Its order of magnitude is the same for low pressures ($\sim 10^{-1}$ mm Hg) as for high pressures ($\sim$ 1 atmos.). A.

535.343.4–14

203. Radiofrequency spectrum of H_2 in a magnetic field. H. G. Kolsky, T. E. Phipps, Jr., N. F. Ramsey and H. B. Silsbee. Letter in *Phys. Rev.*, **79**, 883–4 (*Sept.* 1, 1950).

535.343.4–15

204. Rotation-vibration spectrum of the HD molecule. G. Herzberg. Letter in *Nature, Lond.*, **166**, 563 (*Sept.* 30, 1950).

HD, not being symmetrical like H_2, possesses a small dipole moment. With effective path lengths of 700 to 1 000 m at 1 atmos., lines of the 3–0 and 4–0 bands have been photographed in absorption. New molecular constants are given. A. G. Gaydon

535.343.4–15

205. Infra-red bands in the spectrum of NH_3. D. L. Wood, E. E. Bell and H. H. Nielsen. *Proc. Nat. Acad. Sci., Wash.*, **36**, 497–501 (*Sept.*, 1950).

A preliminary report of new measurements of the 4 fundamental bands, in absorption with a vacuum grating. Tracings are shown. For ν_2 the expected K-components are resolved for low J transitions in the P and R branches. The transition ν_2 $(1 \rightarrow 2)$ is obtained. A. G. Gaydon

535.343.4–31

206. Near ultraviolet absorption spectrum of hydroquinone, resorcinol, and catechol. C. A. Beck. *J. Chem. Phys.*, **18**, 1135–42 (*Sept.*, 1950).

The near u.v. absorption spectra of the three dihydroxybenzenes in the vapour state are measured. 0, 0 values are chosen and compared with benzene. Frequency differences of the main bands are given and some vibrational assignments made. A.

535.343.4–32

207. Absorption spectrum of tin vapour in the Schumann region. W. R. S. Garton. Letter in *Nature, Lond.*, **166**, 690–1 (*Oct.* 21, 1950).

535.36.1/.2

208. The problem of the diffuse reflection and transmission of light. V. V. Sobolev. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 4) 547–50 (1949).

535.371

209. The destruction of luminescence in phosphors by alpha-particles. I. Broser and H. Kallmann. *Z. Naturforsch.*, **5a**, 381–4 (*July*, 1950) *In German.*

Destruction of luminescence by α-particles in four different phosphors is quantitatively studied. Destruction is greatest in pure CdS decreasing in the series CdS, ZnS, Zn_2SiO_4, $CaWO_4$. The decrease in luminescence with α-particle dose is not exponential. In single crystals of CdS the effect depends on the α-particle energy. G. F. J. Garlick

535.371

210. Fluorescence of crystalline magnesium oxide. S. Bhagavantam and P. G. Puranik. Letter in *Curr. Sci.*, **19**, 241 (*Aug.*, 1950).

535.371

211. Theory of the luminescence of sulfide phosphors. S. Roberts and F. E. Williams. *J. Opt. Soc. Amer.*, **40**, 516–20 (*Aug.*, 1950).

Assuming the existence of a killer centre with an unoccupied electronic ground state above the Fermi level and explicitly including the metastable emitting state of the activator and the electron traps in the formulation, the dependence of emission intensity

on excitation intensity for sulphide phosphors is comprehensively treated. The data of Nail, Urbach and Pearlman, which demonstrate that over an intensity range the emission intensity of the $Zn_{0.5}Cd_{0.5}S$: Ag, Ni phosphor is proportional to the 3·5 power of the excitation intensity, are quantitatively reproduced by the theory. The adjustable parameters used to fit the data are shown to be reasonable and to be in accord with other measurements and are used to evaluate the energies of the various electronic states involved. In addition, it is shown that the relation of Klasens and Wise between excitation and emission intensity may be derived as a special case of the general theory. A.

535.371

212. Scintillations in liquids and solutions. M. Ageno, M. Chiozzotto and R. Querzoli. Letter in *Phys. Rev.*, **79**, 720 (*Aug.* 15, 1950).

535.371

213. Temperature characteristics of naphthalene-anthracene mixtures. S. H. Liebson and R. T. Farrar. Letter in *Phys. Rev.*, **79**, 733 (*Aug.* 15, 1950).

535.371

214. Decay time and efficiency of a liquid scintillator. R. F. Post. Letter in *Phys. Rev.*, **79**, 735 (*Aug.* 15, 1950).

535.371

215. On the mechanism of phosphorescence in compounds of variable composition. B. Prégel. *C.R. Acad. Sci., Paris*, **231**, 489–90 (*Aug.* 28, 1950) *In French.*

Solid solutions of CaS and SrS activated by Cu and Cd and excited by ultra-violet followed by 50 kV X-rays, show exponential decays of phosphorescence, in agreement with Perrin's views on metastable states. S. T. HENDERSON

535.371

216. Polarization of the singlet–singlet and triplet–singlet luminescence of chelate compounds. S. I. Weissman. *J. Chem. Phys.*, **18**, 1258–62 (*Sept.*, 1950).

The polarizations of the luminescence of the dibenzoylmethane complexes of Li, K, Al, La and Gd have been determined. The first excited singlet state of the univalent chelates has symmetry B_1. The triplet states have not been uniquely classified. The nature of the perturbation of the triplet state introduced by the magnetic Gd ion seems qualitatively different from the perturbations introduced by non-magnetic ions. A.

535.371

217. Calcium halophosphate phosphors. I. Analysis of emission spectra. K. H. Butler and C. W. Jerome. *J. Electrochem. Soc.*, **97**, 265–70 (*Sept.*, 1950).

Emission curves have been broken down into component bands, each of which has a Gaussian distribution of energy against wave number. An attempt is made to assign the emission bands to specific energy levels of the excited ions and to interpret their changes in terms of crystal structure and location of the activator atoms. A.

535.371

218. Scintillation studies on potassium iodide. B. Smaller, J. May and M. Freedman. *Phys. Rev.*, **79**, 940–5 (*Sept.* 15, 1950).

Studies on the effect of Tl impurity on the fluorescence properties of KI. Coincidence techniques have demonstrated the presence of single photon emission as expected from electron trapping at impurity sites. It has been possible to distinguish between the characteristic radiation due to the impurity and the fundamental or lattice radiation from the pure KI crystal. The fluorescence efficiencies of both types of emission have been determined as a function of temperature. Measurements of the K^{40} radioactivity in the crystal result in the values $\lambda(\beta) = 3{\cdot}90 \times 10^{-10}$ per year and $\lambda(\gamma)/\lambda(\beta) \cong 0{\cdot}05$. Comparison of pulse height distribution with that from Cs^{137} activity gives a provisional $E_{max}(\beta) \cong 1{\cdot}3$ MeV. A.

535.371 : 534.321.9

219. Illumination of phosphors by ultrasonic waves. A. Eckardt and O. Lindig. *Ann. Phys. Lpz.*, 7 (*No.* 7–8) 410–12 (1950) *In German.*

A vessel containing air-free water is closed by a celluloid film covered with phosphor on its upper surface and placed 6–12 cm below a quartz transmitter operating at 70 W and 1·42 Mc/s. The phosphor is first illuminated by an arc lamp with a quartz condenser for about 1 min, and about ½ min after switching off the illumination, the quartz transmitter is energized and the phosphor glows, giving a picture of the sound field which is photographed. When the transmitter has been switched off, a further picture of the sound field can be obtained—this time the parts of the phosphor which had glowed previously now appear as dark zones and a negative picture is obtained. A. C. WHIFFIN

535.372

220. On the existence of "sub-bands" in the luminescence emission spectrum of magnanese activated zinc silicate. C. C. Klick and J. H. Schulman. *J. Opt. Soc. Amer.*, **40**, 509–16 (*Aug.*, 1950).

Failure of the luminescence decay of Mn-activated Zn_2SiO_4 to follow an exact exponential curve has been cited as evidence for the presence of 2 different emitting centres with different decay rates. However, the shapes of the spectral emission curves taken at different times after excitation are identical, showing that if 2 centres exist their emissions are the same. The luminescence emission of this phosphor has also been measured at 4°K and shows a single peak a few hundred angstroms wide. There is little observed change in the emission between 90°K and 4°K. The width of the room temperature emission is therefore the result of the temperature-broadening of an already broad band. No experimental evidence is found for bands predicted on the assumption that emission spectra are formed by the superposition of bands having the shape of Gauss error curves. Theoretical work on the shape of emission and absorption bands is reviewed and does not support the Gauss error curve theory. A.

535.372

221. Spectral emission from scintillation solutions and crystals. F. B. Harrison and G. T. Reynolds. Letter in *Phys. Rev.*, **79**, 732 (*Aug.* 15, 1950).

535.372 : 537.531

222. On the X-ray luminescence spectra of alkali halides. A. CHATTERJEE. *Indian J. Phys.*, **27**, 265–70 (*June*, 1950).

The X-ray luminescence spectra of a few alkali halides have been reported in this paper. The pure crystals get coloured due to new absorption bands, created on irradiation. The emission bands are not characteristic of any impurities present, and hence they represent lattice emission. The importance of lattice emission spectra in elucidating the electronic energy states of solids has been discussed. A.

535.375.5 : 548.0

223. Raman spectra of the second order in crystals. V. Aragonite. R. S. KRISHNAN. *Proc. Indian Acad. Sci. A*, **31**, 435–40 (*June*, 1950).

The Raman spectrum of aragonite crystal has been photographed using λ 2 536·5 excitation. 25 frequency shifts have been recorded as compared to 17 observed previously. They are distributed as follows: 5 due to the internal oscillation of the CO_3 ion, 14 due to lattice oscillation and 6 belonging to the 2nd-order spectrum. The latter have been assigned as some of the octaves and combinations of the fundamental frequencies of vibration of the aragonite structure. A.

535.376

224. Fluorescence of solutions bombarded with high energy radiation (energy transport in liquids). H. KALLMANN AND M. FURST. *Phys. Rev.*, **79**, 857–70 (*Sept.* 1, 1950).

It is experimentally shown that solutions bombarded with high-energy radiation exhibit strong fluorescence when only small amounts of "fluorescent molecules" are added to the solvent. The same amount of fluorescent substance alone would give only about 0·01 of the observed light emission. The large emission in the solution is explained by a transport of excitation energy from the solvent to the fluorescent molecules. An analysis of the energy transport mechanism in the liquid is also given. A.

535.39

225. The optical reflection coefficients of evaporated Al–Ag and Al–Mg alloys. A. BOETTCHER. *Z. angew. Phys.*, **2** (*No.* 8) 340–3 (1950) *In German.*

The reflection coefficients of some evaporated films are measured in the spectral range 2 500–5 000 Å. The variation with composition and structure of Ag–Al and Al–Mg alloys is found. 7% by weight of Al is sufficient to remove the sharp minimum of pure Ag at 3 200 Å. The addition of 2% Ag to pure Al yields a film with u.v. reflection greater than the pure film. The results of previous observers are thought to be affected by the method of preparation of the surface and the presence of an oxide layer.

R. W. FISH

535.39

226. Differential phase change at reflexion. P. M. AITCHISON. Letter in *Nature, Lond.*, **166**, 522–3 (*Sept.* 23, 1950).

Phase change effects are measured on polished and etched glass surfaces which have been silvered, using the multiple-beam interference technique. By measuring steps with light of two different wavelengths the differential phase change can be derived. For etched steps on glass a value of 14° is found. This is attributed to surface roughness. S. TOLANSKY

535.39

227. Some optical properties of evaporated layers of silver, copper and tin. D. G. AVERY. *Phil. Mag.*, **41**, 1018–31 (*Oct.*, 1950).

In earlier work by Tolansky [Abstr. 1091 (1944)], a description was given of the use of multiple-beam interferometry to determine relative phase changes on reflection at the silvered surfaces of an interferometer. This method has been extended and critically examined. It is shown that the method does not approach the accuracy of the older polarimetric methods, and that its optimum use is restricted to reflecting surfaces of fairly high reflection coefficient. Within its limitations the method has advantages. Measurements of the relative phase changes on reflection at a number of layers of Ag, Cu and Sn have been made, together with measurements of the ellipticity of the light reflected at these layers. The variation of these quantities with the thickness of some layers of Ag has been discussed in relation to the use of evaporated layers for the measurement of the optical constants of bulk materials, and the optical constants of evaporated layers of Cu and Sn have been determined and the results discussed. A.

535.39 : 535.417

228. Application of the double slit interferometer to the measurement of phase shift of light transmitted through thin films. K. ISHIGURO. *J. Phys. Soc., Japan*, **5**, 187–92 (*May–June*, 1950).

The phase displacement produced by the passage of light through a semi-transparent metal film is measured by interposition of the film (on a base) in one beam of a Rayleigh two-slit interferometer. Observations are recorded for thin films of Ag, Pb, ZnS, AgBr. Film thickness is approximately established from evaporation of a known mass of material. An advancing phase is established for Hg and a retardation for Pb. S. TOLANSKY

535.39 : 535.417

229. Reflectivity of thin silver films and their use in interferometry. H. KUHN AND B. A. WILSON. *Proc. Phys. Soc., Lond. B*, **63**, 745–55 (*Oct.*, 1950).

A direct photo-electric method allowed the reflectivity R and the transmissivity T of partially reflecting films to be measured to an accuracy of 0·3% of the incident light intensity. For a large number of Ag films, deposited on glass by evaporation *in vacuo*, the values of R and T were measured for visible light of 5 different wavelengths, in the range of high reflectivities ($R > 0·7$). The change of R as a function of time was also studied. With only moderate control of the conditions of surface cleaning and evaporation, the values of R were nearly always found to lie close to a "standard" curve giving R as a function of T, the wavelength, and the age of the film. Possible causes of scatter from this standard curve were investigated. T was found not to obey an exponential law as a function of the thickness. On the basis of these results, resolving power and brightness of etalon fringes were plotted as functions of T. The conclusion is reached that, in most practical

cases, the resolving power of etalons for visible light is limited by imperfections of the surfaces rather than by the reflectivity of the Ag films, if their thickness is properly chosen. A.

535.417

230. Some aspects of Twyman fringes. A. Maréchal and P. Dejonc. *Rev. Opt. (Théor. Instrum.)* **29,** 430–8 (*Aug.–Sept.*, 1950) *In French.*

A number of illustrations are given of typical optical aberrations, as revealed by the Twyman–Green interferometer. Lens errors of various kinds are illustrated, including spherical aberration (3rd and 5th order), coma, astigmatism and circle of least confusion. No new principles are developed.

S. TOLANSKY

535.42

231. A reciprocal diffraction effect. P. E. Weber. *Optik*, 7 (*No.* 1) 27–32 (1950) *In German.*

By superimposing a number of coherent beams with amplitudes, phases and angular spacing equal to those of beams formed by diffraction, the reciprocal diffraction effect yields a grating-like image. The necessary conditions are given and the results of including only the first few orders considered. The effect can be demonstrated practically, using a multiple system of beam-splitting surfaces and mirrors to introduce the necessary phase and amplitude differences. R. W. FISH

535.42

232. The "minimum-ray concept" as a means of increasing the accuracy of optical measurements and as a methodical help in replacing the concept of a ray. H. Wolter. *Ann. Phys., Lpz.*, 7 (*No.* 7–8) 341–68 (1950) *In German.*

An analogy is derived between lack of optical ray-sharpness and Heisenberg's uncertainty relation. The slit-image sharpness can be considerably improved at the expense of energy. An improvement by a factor of $\times 26$ in accuracy is attainable with simple means in some cases. This is achieved by means of a phase-plate which leads to mutual interference of two parts of the beams normally forming a typical diffraction image. Various phase-plates are described for introducing a retardation in half the beam. For a rotating mirror (e.g. galvanometer mirror) the phase retardation is obtained by coating half the mirror with a $\lambda/4$ thickness layer. The technique leads to a fine dark minimum running down the centre of the diffraction image. The theory is developed in detail. Application to double-beam interference systems, such as the biprism, is described.

S. TOLANSKY

535.42

233. Diffraction and the quantity of information. A. Blanc-Lapierre and M. Perrot. *C.R. Acad. Sci., Paris*, **231,** 539–41 (*Sept.* 11, 1950) *In French.*

Given an aperture, the diffraction figure at infinity can be found of an object also at infinity and composed of non-coherent sources. From the correspondence between the diffraction figure and the object, an evaluation of the amount of information that can be transmitted through the aperture is obtained. This is shown in simple cases to vary inversely as the square of the normal linear resolving power. R. W. FISH

535.42 : 534.321.9

234. Diffraction of light by ultrasonic waves. R. R. Aggarwal. *Proc. Indian Acad. Sci. A*, **31,** 417–26 (*June*, 1950).

Expressions for the intensities of the 1st- and 2nd-order diffracted lines are calculated on the basis of the generalized theory of Raman and Nath. Earlier simplified theories are shown to be special cases and the conditions in which they apply are discussed. The generalized theory is shown to be true at all frequencies. 12 references are given. R. W. FISH

535.421

235. Diffraction gratings and the plane mirror. E. Hulthén and E. Lind. *Ark. Fys.*, **2,** *Paper* 24, 253–70 (1950).

Systems are discussed in which a plane mirror is placed in the blaze direction of the diffracted beam from a grating, so reflecting the beam back for a second diffraction. This leads to systems with increased spectroscopic resolution and of greater brilliance. Application to both plane and concave gratings is possible, the latter leading to some new grating mountings. Practical details of these mountings are given and results obtained are illustrated.

R. W. FISH

535.421

236. A new mounting for an echelette diffraction grating. J. H. Greig and W. F. C. Ferguson. *J. Opt. Soc. Amer.*, **40,** 504–6 (*Aug.*, 1950).

With this mounting a single ruled echelette grating may be used "in the blaze" over a very wide range of wavelengths. This is accomplished by tilting the grating with respect to the incident light as in a Littrow mounting, and then rotating the grating about an axis perpendicular both to the grating elements and the incident beam. By this rotation the path difference between beams of light reflected from successive elements of the grating may be varied from a maximum value, the ordinary blaze wavelength, to zero. The spectrum reflected from the grating may then be reflected from a plane mirror, rotating with the grating, to produce a constant-deviation mounting. The image of the slit is found to be tilted as the grating rotates. This can be compensated by a rotation of the slit. In a trial, using an echelette designed for the near infrared, all orders of the sodium *D*-lines from the 5th to the 1st were caused to pass an observing telescope, successively in the blaze, by a 55-degree rotation of the grating mounting.

A.

535.428

237. Elliptic polarisation of light scattered by Perspex glass. A. George. Letter in *Curr. Sci.*, **19,** 239–40 (*Aug.*, 1950).

535.43 : 548.0

238. Thermal scattering of light in crystals. I. Quartz. R. S. Krishnan and V. Chandrasekharan. *Proc. Indian Acad. Sci. A*, **31,** 427–34 (*June*, 1950).

Using the $\lambda 2536{\cdot}5$ mercury resonance radiation and a 3-metre quartz spectrograph, the fine structure of the thermal scattering of light in crystalline quartz has been investigated. The scattered spectrum

exhibits only one pair of Doppler-shifted or Brillouin components due to the longitudinal sound waves in the medium. The observed frequency shift is in good agreement with the value calculated from the known elastic constants of quartz. The dependence of the frequency shift of the Doppler components on the orientation of the crystal with reference to the directions of incidence and scattering has been quantitatively verified for 7 different settings of the crystal. The temperature variations in intensity of the shifted components has also been investigated and is found to be in accordance with the theory of scattering. In the 1st-order Raman spectrum, a new Raman line with a frequency shift of 26 cm^{-1} has been recorded. A.

535.435

239. Scattering of light (Rayleigh effect) by solutions of anisotropic ions or molecules. R. Lochet. *C.R. Acad. Sci., Paris*, **231**, 437–9 (*Aug.* 16, 1950) *In French.*

The degree of anisotropy of ions is calculated from the depolarization factors of the scattered light (*a*) when the incident light is polarized, and (*b*) when it is not polarized. The result obtained for a dilute soln. of $C_6H_5NO_2$ in CCl_4 agrees with that obtained for the vapour, not the liquid. For soln. of nitrates, the degree of anisotropy is about 3 times that of the nitrate ion in crystals. N. CORCORAN

535.55 : 532.517.4

Turbulence in apparatus for measurement of streaming double refraction. *See Abstr.* 112

535.55 : 539.32

Elastic and photoelastic properties of some optical glasses. *See Abstr.* 669

535.565

240. Optical rotatory power of benzoin. T.-C. Kwoh and H. Eyring. *J. Chem. Phys.*, **18**, 1186–92 (*Sept.*, 1950).

The procedure for calculating the optical rotatory power due to one electron transitions in an asymmetric field is simplified and systematized. The necessary transformations of functions to elliptic coordinates is carried through explicitly and the method of calculation is outlined. Extensive tables and graphs were prepared which greatly simplify the calculations. The method is applied to benzoin and the results are compared with the published experimental results which vary characteristically with the solvent. Representing transitions by eigenfunctions involving changes in more than one electron is the next natural but difficult improvement in this type of treatment. A.

535.568.1

241. A recording polarimeter. G. B. Levy, P. Schwed and D. Fergus. *Rev. Sci. Instrum.*, **21**, 693–8 (*Aug.*, 1950).

The principle of operation is essentially the replacement of an operator in conventional visual polarimetry by a photo-electric servo system. A photomultiplier tube is used which, in conjunction with a mechanical chopping system, delivers an alternating current signal proportional to the unbalance. The latter is filtered and amplified and actuates a servo mechanism. The precision of the system is $\pm 0{\cdot}005°$ for static balance and the speed about $0{\cdot}5°$ per minute. Hence the arrangement compares favourably with ordinary visual operation. The construction of the instrument is discussed briefly and its performance is illustrated by examples. A.

535.568.1

242. A photoelectric polarimeter. D. H. Rank, J. H. Light and P. R. Yoder, Jr. *J. Sci. Instrum.*, **27**, 270–1 (*Oct.*, 1950).

A cooled multiplier phototube and d.c. amplification are used. The extinction point of crossed Nicol prisms is recorded electronically for any desired wavelength. Continuous rotation through the extinction point is facilitated by synchronous motor drive for each wavelength. Measurement of optical rotation is done directly on the recorder chart to an accuracy of $0{\cdot}03°$, which is the predicted limit for Nicol prisms. Considerable improvement would result upon substitution of Glazebrook prisms to reduce width of the extinction minimum. A.

535.8

243. Reference wedge for *Schlieren* diagrams. H. Hoch. Letter in *Nature, Lond.*, **166**, 402–3 (*Sept.* 3, 1950).

A device is described which permits analysis of spread patterns (as in electrophoresis observations). A base line is produced optically with practical advantages. The method described is applied to electrophoretic patterns of a muscle protein extract. S. TOLANSKY

535.81 : 535.42

244. Study of defects of homogeneity by the shadow method. D. Wagner. *Rev. Opt. (Théor. Instrum.)* **29**, 419–29 (*Aug.–Sept.*, 1950) *In French.*

A plane-parallel glass specimen is placed between a small illuminated pin-hole and a diffusing screen. The fringe system produced in the screen by a vein of phase-thickness ϕ is calculated. It is shown that, under optimum conditions, the method has the same sensitivity as the phase-contrast method, using a non-absorbing phase-strip, i.e. the limiting path difference $\approx \frac{\lambda}{180}$. When ϕ is small it is advantageous to use a specimen in the form of a lens. It is shown that the apparent angular size of the source should not exceed 2′ for ϕ small ($< 10'$ for average ϕ). The effects have been studied experimentally using a Lyot compensator. H. H. HOPKINS

535.822 : 535.33.07–15

An infra-red microspectrometer for biological research. *See Abstr.* 179

535.823.5

245. A high-low temperature microscope stage. R. E. Cech. *Rev. Sci. Instrum.*, **21**, 747–9 (*Aug.*, 1950).

Permits microscopic observation of metal specimens from the temperature of liquid N to an upper temperature usually determined by the m.p. of the specimen. The stage consists of a vacuum-tight water or liquid-N-cooled Cu chamber in which a specimen is heated by passage of an electric current. A quartz window in the chamber permits "at temperature" observation of the specimen. Operation of this stage is described. A.

535.824.2

246. Lens centering in microscope objectives. G. Wooters. *J. Opt. Soc. Amer.*, **40**, 521–3 (*Aug.*, 1950).

When a lens is decentred in a microscope objective the most noticeable defect is coma in the centre of the field. A method is given for computing the central coma by using the transfer coefficients of M'Aulay and Cruickshank. The results for a typical microscope are given and the experimental means of verification are described. A.

535.824.8

247. The influence of the condenser on microscopic resolution. H. H. Hopkins and P. M. Barham. *Proc. Phys. Soc., Lond. B*, **63**, 737–44 (*Oct.*, 1950).

An expression is found for the distribution of light in the image of two small apertures which are illuminated by a condenser of numerical aperture equal to s times that of the imaging objective. The resolving power of the system is written $\rho = K\lambda/(\text{N.A.})$, and K is found as a function of s. It is shown that precisely the same result obtains for both critical and Köhler illumination. A.

535.833

248. Anallactic telescope systems. H. Jensen. *Optik*, **7** (*No.* 1) 16–22 (1950) *In German.*

Simplified expressions are obtained for the position of the anallactic point of a telescopic system with an internal focusing lens, the variables being the overall length of the telescope, the focal lengths of the lenses and their separation. This leads to a discussion of all the possible systems whose anallactic points lie at the centre of the telescope. Unusual systems, some with negative telescope O.G.s, are shown to be possible although very few are of use in practical instruments. R. W. FISH

535.833

249. The theory of anallactic points. M. Drodofsky and H. Slevogt. *Optik*, **7** (*No.* 1) 23–6 (1950) *In German.*

Relationships are derived between the position of the anallactic point and the optical constants of an internally focusing telescope. Conditions for this point to be central and to have the smallest variation with focusing are obtained. R. W. FISH

HEAT 536

536.21

250. Conduction of heat in a solid with a power law of heat transfer at its surface. J. C. Jaeger. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 4) 634–41 (1950).

A semi-infinite slab is considered, and recurrence relations are found for the coefficients of the series solution. Where the series is not rapidly convergent, a numerical method is suggested, based on a finite difference approximation to the heat equation (ascribed to Schmidt). The difference equation can be solved exactly for a simple source and it is shown that the average of the numerical values at neighbouring points tends to the actual temperature for large values of the time. Curves are given at the surface temperature for various cases. S. MICHAELSON

536.2

251. New measurements of the heat conductivity of steam and nitrogen. F. G. Keyes and D. J. Sandell Jr. *Trans Amer. Soc. Mech. Engrs*, **72**, 767–7 (*Aug.*, 1950).

The heat conductivity of steam has been measured by Timroth and Vargaftig (1940). The new measurements in the present paper were obtained using a concentric cylinder type of conductivity cell in which the heater and thermometric parts were isolated from contact with the material whose conductivity was being measured. Vargaftig had published (1937) measurements of the heat conductivity of N in substantially the same cell used for steam. The new measurements on N are in tolerable agreement with the Vargaftig measurements, but in the case of steam the new measurements are considerably lower in magnitude. A comparison of the 2 sets of steam data indicates some peculiarities of temperature trend in the Timroth and Vargaftig data which find no correspondence in the data of any other substance, and also differs from the trend relative to the new data. A formulation of the steam and N data is given in terms of pressure and temperature as independent variables. A

536.23 : 536.

252. Compilation of thermal properties of wind tunnel and jet-engine gases at the National Bureau of Standards. H. J. Hoge. *Trans Amer. Soc. Mech. Engrs*, **72**, 779–83 (*Aug.*, 1950).

A project for the preparation of a series of tables of thermal properties of gases is described. This project was undertaken by the National Bureau of Standards at the suggestion and with the co-operation of the National Advisory Committee for Aeronautics. The scope of the project, tables now available, work in progress, and plans for the future are described. The lack of adequate data at high temperatures and also at high pressures is pointed out. A

536.2

253. Heat transfer to a fluid flowing turbulently between parallel walls with asymmetric wall temperatures. R. A. Seban. *Trans Amer. Soc. Mech. Engrs*, **72**, 789–93 (*Aug.*, 1950).

On an analytical basis, an extension of the work of Martinelli and of Harrison and Menke. Therefore only conditions for a flow fully developed from the hydrodynamic and thermal standpoint are considered. It is shown that the existence of solutions for the case of one adiabatic wall enables the specification of the temperature distribution and heat-transfer coefficients for cases in which the walls have any uniform temperature values. The effect of inequality in the wall temperatures is shown to be small for Prandtl numbers greater than unity but significant for fluids of low Prandtl number, such as molten metals. To facilitate its use in the present applications, the existing solution for one adiabatic wall is extended. A.

536.24 : 533.15

Unsteady-state diffusion or heat-conduction with moving boundary. *See Abstr.* 125

536.255

254. Convection currents in porous media. III. Extended theory of the critical gradient. F. T. ROGERS, JR. AND H. L. MORRISON. *J. Appl. Phys.*, **21**, 1177–80 (*Nov.*, 1950).

The theory of the critical gradient for onset of thermal convection in a fluid entrapped in a porous medium is extended to allow for the exponential dependence of viscosity upon temperature and for non-linear vertical temperature-distributions which characterize transients in heat flow. Although there are approximations in the mathematical treatment, the extended theory agrees rather well with experimental data, as the simple theory does not in certain instances. New experimental data are reported for the critical gradient, obtained largely with silicone fluids in unconsolidated sands. A.

536.423.1

255. An influence of cooling by vaporization on vaporization velocity. Y. MIMURA. *J. Sci. Hiroshima Univ.*, **14**, 127–34 (*March*, 1950).

Vaporization velocity depends on liquid temperature, and the latter is lowered by the vaporization, this diminishing vaporization velocity in turn. These secondary effects were investigated by the theory of heat conduction and vapour diffusion. Applying the general consideration to some cases, the character of the solution of the equations was investigated in detail. For some cases numerical calculations for water and ether were carried out. A.

536.423.15

256. The vapor pressure of normal hydrogen from the boiling point to the critical point. D. WHITE, A. S. FRIEDMAN AND H. L. JOHNSTON. *J. Amer. Chem. Soc.*, **72**, 3927–30 (*Sept.*, 1950).

This can be represented by the equation $\log p_{atm} = 3{\cdot}068281 - 55{\cdot}25642/T - 3{\cdot}1282 \times 10^{-2}\,T + 6{\cdot}6989 \times 10^{-4}T^2$. The boiling point calculated from this equation is 20·40°K. The heat of vaporization at the boiling point as calculated from this equation is 218·7 cal/mole. This value is in good agreement with the value 219·3 cal/mole for normal H, computed by Johnston, Rifkin and Kerr from their accurate calorimetric value of 214·8 for pure para H. A.

536.423.15

257. The vapour pressure of liquid nitrogen. A. S. FRIEDMAN AND D. WHITE. *J. Amer. Chem. Soc.*, **72**, 3931–2 (*Sept.*, 1950).

The vapour pressure of N from the b.p. to the critical point has been determined and can be accurately represented by the equation $\log P_{atm.} = 3{\cdot}720822 - 293{\cdot}94358/T + 10{\cdot}31993 \times 10^{-4}\,T$. The calculated b.p. of N from this equation is 77·34°K, and the molal heat of vaporization at the boiling point is 1 320 cal/mole. A.

536.453 : 533.5 : 621.365.4

258. A small high-temperature high-vacuum furnace. K. B. ALBERMAN. *J. Sci. Instrum.*, **27**, 280–2 (*Oct.*, 1950).

A small and convenient high-temperature vacuum furnace has been constructed, suitable for heating gram quantities of material at temperatures up to 2 500°C under pressures of $10^{-4} - 10^{-5}$ mm Hg. The limiting factor in the design is the creep rate of the W heating elements used. A.

536.46

259. The shadow cast by a bunsen flame, its production and usefulness. J. R. GROVE, M. F. HOARE AND J. W. LINNETT. *Trans Faraday Soc.*, **46**, 745–55 (*Sept.*, 1950).

The mode of formation of the shadow cast by the inner cone of a Bunsen flame has been studied. On the basis of a simple model the main features of the shadow picture have been accounted for both qualitatively and quantitatively. The method of Sherratt and Linnett for determining burning velocities gives results that are in error by an amount depending on the magnification employed and the level in the cone which is considered. With their particular experimental arrangement the measured burning velocity over the whole cone is about 4% too high. Necessary modifications are suggested. A.

536.46

260. Influence of sulphur on carbon formation in diffusion flames. H. G. WOLFHARD AND W. G. PARKER. *Fuel*, **29**, 235–40 (*Oct.*, 1950).

When SO_2 was introduced into either the fuel or O gas it was converted into other S compounds, each of which had a definite position in the flame. The location and nature of these compounds could be roughly predicted from considerations of chemical equilibrium. S_2 molecules which were found near the C zone probably reacted with the C and produced CS molecules. The C zone luminosity was thereby reduced. SO_3 in contrast to its behaviour in a premixed gas flame was similar in effect to SO_2 in the diffusion flame because it quickly dissociated. It is concluded that small percentages of SO_2 or SO_3 do not noticeably influence C formation in diffusion flames. A.

536.48

261. A new method for measuring film transport in liquid He II. H. A. BOORSE AND J. G. DASH. Letter in *Phys. Rev.*, **79**, 734 (*Aug.* 15, 1950).

536.48 : 530.162

262. Erratum: Statistical mechanics of liquid mixtures of He^3 and He^4. J. DE BOER AND C. J. GORTER. *Physica*, **16**, 667–8 (*July–Aug.*, 1950).

See Abstr. 5780 (1950).

536.48 : 530.162

263. Non-equilibrium phenomena in a Bose–Einstein gas. II. Heat transfer. W. BAND. *Phys. Rev.*, **79**, 589–92 (*Aug.* 15, 1950).

The model Bose–Einstein gas introduced in Part I [Abstr. 5400 (1949)] is shown to yield superconductivity for heat transfer. The temperature dependence and order of magnitude of the thermal conductivity are shown to be the same as in liquid He below the lambda-point. A.

536.48 : 532.7

264. The zero-point energy of helium. C. L. PEKERIS. Letter in *Phys. Rev.*, **79**, 884–5 (*Sept.* 1, 1950).

A solution is found of the Schrödinger equation for an atom trapped within the cage imagined in the Lennard–Jones and Devonshire theory of liquids,

and the density, zero-point energy and compressibility calculated. These agree with the observed values for He if a co-ordination number $\sim 9{\cdot}5$ is assumed.

R. B. DINGLE

536.48 : 534.22

265. The velocity of second sound in mixtures of He^3 and He^4. E. A. LYNTON AND H. A. FAIRBANK. Letter in *Phys. Rev.*, **79**, 735–6 (*Aug.* 15, 1950).

536.48 : 536.421.4

266. The liquid-solid transformation in helium near absolute zero. C. A. SWENSON. *Phys. Rev.*, **79**, 626–31 (*Aug.* 15, 1950).

Although He is normally a liquid to absolute zero, it can be solidified by the application of moderately high pressures. This transformation is of particular interest, since by the 3rd law of thermodynamics the entropy difference between the liquid and the solid must disappear as the absolute zero is approached. This can most easily be shown by the disappearance of the heat of melting. Measurements from $1{\cdot}0°$ to $1{\cdot}8°$ of the slope of the melting pressure curve and the change in the molar volume of He on melting are described, from which the heat of melting and the change in internal energy on melting were calculated. These results verify the predictions made by the 3rd law. The measurements are also combined with those due to earlier workers to show the discontinuities in the various thermodynamic functions at the intersection of the λ-point-pressure curve with the melting pressure curve. A.

536.48 : 536.423.15

267. A note on the vapour pressure of He^3, He^4 solutions. J. E. KILPATRICK. Letter in *Phys. Rev.*, **79**, 529–30 (*Aug.* 1, 1950).

A theoretical calculation taking into account the fact that the vapour does not behave as a perfect gas. The values of the partial pressure of He^3 are about 10% less than those obtained assuming the vapour to be ideal. R. B. DINGLE

536.483 : 538.247

268. The attainment of very low temperatures by a two-stage adiabatic demagnetization process. J. DARBY, J. HATTON AND B. V. ROLLIN. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1179–81 (*Oct.*, 1950).

536.49 : 535.327 : 535.55

269. The relation between thermal transformation of glass and internal stress. A. WINTER-KLEIN AND F. NAUDIN. *C.R. Acad. Sci., Paris*, **236**, 516–17 (*Sept.* 4, 1950) *In French.*

Refractive index and birefringence are measured simultaneously. Both properties show transformation within the same temperature range. R. O. DAVIES

536.531

270. Machine computation of relation between resistance and temperature of a resistance thermometer. D. R. STULL. *Analyt. Chem.*, **22**, 1172–4 (*Sept.*, 1950).

The problem of finding the temperature for a measured value of the resistance is solved by constructing a table of resistances for even values of temperature. For a precision of $0{\cdot}001°$C, these temperature values should be at about every degree for linear interpolation in between. In this way, repetitive calculation demanding 6-place accuracy arises. International business machines have been employed in this computation. The time required for manual calculating machine operation is approximately decimated by the automatic machines operating with punched cards. A.

536.532

271. The use of platinum thermocouples in vacuo at high temperatures. A. G. METCALFE. *Brit. J. Appl. Phys.*, **1**, 256–8 (*Oct.*, 1950).

In the course of thermal analysis on Co base alloys *in vacuo* with Pt–Pt 13% Rh thermocouples it has been found that the e.m.f. developed at any temperature gradually falls. The principal cause of this is believed to be the transfer of Rh to the Pt wire via the vapour phase. It has been shown that this effect can be reduced considerably by the use of a Pt 1% Rh wire in place of the Pt wire. A.

536.631

272. Specific heats of certain salts of iron group elements from 65° to 300°K. H. D. VASILEFF AND H. GRAYSON-SMITH. *Canad. J. Res. A*, **28**, 367–76 (*July*, 1950).

Using a new low temperature calorimeter, which is briefly described in the paper, the specific heats have been measured from 65° to 300°K for the following salts: $Cr_2(SO_4)_3$ (hydrated and anhydrous), $Cr(NO_3)_3$, $Co(NO_3)_2$ and $Ni(NO_3)_2$ (hydrated). Hydrated $Cr_2(SO_4)_3$ was found to have a transition of the second order at 195°K, while the specific heat of the anhydrous salt was quite regular. The hydrated nitrates all showed second order transitions in the neighbourhood of 150°K. The entropy changes associated with these transitions have been estimated approximately, and vary from about $0{\cdot}4R$ for $Co(NO_3)_2$ to $1{\cdot}65R$ for $Cr(NO_3)_2$, where R is the gas constant. Pending further evidence, it is tentatively suggested that the transitions are due to the onset of partial rotation of the H_2O groups in the crystals. A.

THERMODYNAMICS 536.7/.8

536.7

273. Thermodynamic relations in n-variable systems in Jacobian form: I. General theory and applications to unrestricted systems. F. H. CRAWFORD. *Proc. Amer. Acad. Arts Sci.*, **78**, 165–84 (*April*, 1950)

An extension of results given previously [*Amer. J. Phys.*, **17**, 1 (1949)] to the case of n independent variables. Two cases arise depending upon whether or not there are special functional restrictions on certain variables throughout. The present paper deals with unrestricted or general systems where no such restrictions exist. A general theory is developed which allows expressions for required 1st-order derivatives to be written down with a minimum of effort. Several examples are given of the application of the methods up to 10 independent variables (the general piezo-electric crystal). F. E. HOARE

536.7 : 530.162

274. The statistical method of Gibbs in irreversible change. R. T. COX. *Rev. Mod. Phys.*, **22**, 238–48 (*July*, 1950).

The treatment of irreversible processes by statistical

methods has been mainly by an extension of Boltzmann's method. Gibbs' method may also be extended in a general way to the description of irreversible processes and several examples of this are given. Onsager's reciprocal relations are obtained by a method differing from the original deduction and other somewhat similar reciprocities obtained. A discussion of equilibrium serves to show the consistency of the treatment of irreversible processes with that already familiar in the theory of equilibrium.

F. E. HOARE

536.7 : 548.7

A method of approximation for cooperative phenomena. *See Abstr.* 748

536.71

275. Zero-pressure thermodynamic properties of some monatomic gases. J. A. GOFF, S. GRATCH AND S. W. VAN VOORHIS. *Trans Amer. Soc. Mech. Engrs*, **72,** 725–39 (*Aug.*, 1950).

This paper presents definitive values of the zero-pressure thermodynamic properties of the stable naturally occurring isotopes and the normal isotopic mixtures of the following monatomic gases: H, He, C, N, O, F, S, Cl, A, Br, I, Hg. These values cover the range 100° to 5 000°R at the intervals indicated by the numbers in parentheses: 100(5)130(10)240(20)500(50)1 000(100)2 000(200)5 000. They have been computed by the methods of quantum statistical mechanics from present best values of the relevant (*a*) general physical constants, (*b*) isotopic weights and fractional abundances, (*c*) spectroscopic data. Computational accuracy well beyond present physical accuracy has been maintained for practical reasons, final results bring given to 7 significant figures. Present physical accuracy is indicated by charts of estimated uncertainties. For some of the monatomic gases here considered, accurate values of their zero-pressure thermodynamic properties hitherto have been unavailable; for others the data presented are the first based upon recent spectroscopic and other input data to be made available at temperatures sufficiently close for convenient practical application. A.

536.71

276. Zero-pressure thermodynamic properties of carbon monoxide and nitrogen. J. A. GOFF AND S. GRATCH. *Trans. Amer. Soc. Mech. Engrs*, **72,** 741–9 (*Aug.*, 1950).

In this report are presented tables of the principal thermodynamic properties of CO and of N along the zero-pressure isobar in the range 100° to 5 000°R at the intervals indicated by the numbers in parentheses as follows: 100[5]130[10]240[20]500[50]1 000[100]2 000[200]5 000. The data have been computed by the method of quantum statistical mechanics. Computational accuracy well beyond present physical accuracy has been maintained for practical reasons. It is believed that the tables given herein should supersede all previous ones. The calculated values are in satisfactory agreement with those obtained from calorimetric and acoustic velocity measurements. A.

536.71

277. The thermodynamic properties of helium. S. W. AKIN. *Trans Amer. Soc. Mech. Engrs*, **72,** 751–7 (*Aug.*, 150).

Evaluation has been made of the density, enthalpy, entropy, viscosity and thermal conductivity of He in the range of pressures from atmospheric to 6 000 psia and at temperatures from − 440°F to 600° F. These data are composed of observed values published prior to 1945, and of extrapolations based upon the Beattie–Bridgeman equation of state and kinetic theory. The results evaluated to 4 significant figures are tabulated for particular values of pressure and temperature. Graphic plots of the same information are also presented, with an accuracy sufficient for investigations of flow and heat-transfer processes involving high-pressure He. A.

536.71

278. Some new values of the second enthalpy coefficient for dry air. J. R. ANDERSEN. *Trans Amer. Soc. Mech. Engrs*, **72,** 759–65 (*Aug.*, 1950).

Measurements of the second enthalpy coefficient for dry CO_2-free air are reported for 3 temperatures: 0°c, 10°c and 30°c. These values, which are in excellent agreement with the best data on air in the literature, were formulated, together with the data of Eucken, Clusius, and Berger by the equation $\beta = -0{\cdot}05442G(0{\cdot}01244\,T)$, ft³/lb. The second virial coefficient was then calculated by means of the equation $B = 0{\cdot}05442\,F(0{\cdot}01244\,T) - 2{\cdot}33\times10^{-5}T$, ft³/lb, where the value of the constant of integration was adjusted to give the best fit with the Holborn and Schultze compressibility data. These equations represent adequately all reliable data on air in the temperature range − 80°c to 200°c. The functions F and G are the well-known Lennard–Jones functions, abridged tables of which are given in the Appendix. A.

536.71

279. Thermodynamic properties of gaseous carbon dioxide at temperatures from 0°–600°C, and pressures up to 50 atmospheres. K. E. MACCORMACK AND W. G. SCHNEIDER. *J. Chem. Phys.*, **18,** 1273–5 (*Sept.*, 1950).

Compressibility data presented in a previous paper have been used in conjunction with spectroscopically determined zero pressure specific heat data for CO_2, to calculate thermodynamic properties over the temperature range 0°–600°c at pressures up to 50 atmospheres. A.

536.71

280. The thermodynamic functions of hydrogen peroxide. P. A. GIGUÈRE. *Canad. J. Res. B*, **28,** 485–91 (*Aug.*, 1950).

Using structural data and vibrational frequencies measured recently, these were calculated by the statistical method over the range 298·16 to 1 500°K at 100° intervals. Some uncertainty results from the lack of accurate information on the potential barrier hindering free rotation of the OH groups in the molecule. The equilibrium constants of a few important reactions involving H_2O_2 were also calculated from existing data on the heat of decomposition and the heat of dilution. A.

536.75

281. Irreversibility. E. SCHRÖDINGER. *Proc. Roy. Irish Acad.*, **53A,** 189–95 (*Aug.*, 1950).

To avoid the logical contradiction between the

irreversibility law and its deduction from reversible models, without appealing to the concepts of quantum mechanics, it is suggested that the entropy law be formulated in terms of two systems, 1 and 2, in the form $(S_{1B}-S_{1A})(S_{2B}-S_{2A}) \geqslant 0$, where A and B are two times ($t_B > t_A$) between which the systems are separated, while before A and after B they are in contact. G. J. KYNCH

536.753 : 532.73

282. Entropies of mixing in certain athermal binary solutions. E. A. GUGGENHEIM AND M. L. MCGLASHAN. *Proc. Roy. Soc., A*, **203**, 435–54 (*Oct.* 24, 1950).

Approximate formulae for the entropy of mixing of binary athermal mixtures can be obtained by means of the model, first used by Fowler and Rushbrooke, of a lattice on which molecular species differ from one another in the number and relative orientation of the lattice points which a single molecule occupies. The previous work of Chang, Huggins, Miller and Guggenheim on open chain molecules has here been extended to molecules having the shapes of equilateral triangles, regular tetrahedra and squares. It is found that the entropy of mixing depends less on the shapes of the molecules than on their relative sizes. Flory's formula, which corresponds formally to letting the co-ordination number z tend to infinity, gives a considerably better approximation to our values than does the formula for ideal solutions. A.

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.212

283. The electric field strength between two curved electrodes. F. UNGER. *Abh. Braunschw. Wiss. Gesell.*, **1**, 116–20 (1949) *In German.*

An approximate method is given for finding the strength of the electric field at a given point between two electrodes with curved surfaces. Two cylindrical surfaces standing in a rectangular angle to each other are placed at the electric field line touching the given point. Their intersections with the surfaces of the electrodes near this line are equi-potential lines and it is possible to place a square net (following Lehmann) between the corresponding intersections of both electrodes. This results in a field tube of rectangular cross-section enveloping this point. A.

537.221

284. Frictional electrification and gaseous discharge. J. A. MEDLEY. Letter in *Nature, Lond.*, **166**, 524–5 (*Sept.* 23, 1950).

Experiments are described on the electrification of wool and nylon fibres by friction against metal cylinders. Fibres whose conductivities change rapidly with relative humidity show a constant electrification around 3 e.s.u./cm². The electrification then drops rapidly as R.H. and conductivity increase further. It is suggested that the limit to electrification in the constant region is due to a breakdown of the air near the surface. J. H. FREMLIN

537.226

285. Microwave techniques for the measurement of the dielectric constant of fibres and films of high polymers. T. M. SHAW AND J. J. WINDLE. *J. Appl. Phys.*, **21**, 956–61 (*Oct.*, 1950).

A resonant cavity method is described. Methods for investigating electrical anisotropy are outlined. In the case of fibres, for the electric field parallel to the fibre axis, the dielectric constant is determined directly. For the electric field perpendicular to the fibre axis, the problem arises of calculating the dielectric constant of the fibre from that of an air-fibre mixture. For the latter purpose the Lichtenecker equation was found to be applicable. Illustrative measurements of the dielectric constant of wool, Nylon and Cellophane are presented and discussed briefly. A.

537.226.2

286. The dielectrical anisotropy of natural wood over a wide frequency range. K. KRÖNER AND L. PUNGS. *Abh. Braunschw. Wiss. Gesell.*, **1** (*No.* 1) 101–8 (1949) *In German.*

The dielectrical anisotropy of wood (spruce, beech and oak) in absolutely dry condition is determined by measurements of the dielectrical constant in the frequency range of 3×10^2 to 10^9 c.p.s. It is found that the anisotropy is mainly caused by the macroscopical structure of wood as a compositum of cellular substance and air. An anomalous dispersion of the dielectrical constant is found. The variation of the dispersion caused by different directions of the electrical field is explained likewise by the mixed structure. A.

537.226.2

287. On a new method for the measurement of dielectric constants of liquids of low conductivity in the cm-wave region. E. LEDINEGG, P. URBAN AND F. REDER. *Acta Phys. Austriaca*, **4** (*No.* 1) 9–17 (1950) *In German.*

This method works for higher frequencies than the usual resonator methods and involves the measurement of a volume of liquid rather than of a differential length. The resonance curve for various volumes of test liquid is very sharp and permits of the rapid determination of dielectric constant to a few parts per thousand. The method is used for the examination of the structure of liquids. C. A. HOGARTH

537.226.2

288. Dielectric constants of non-polar fluids. I. Theory. W. F. BROWN, JR. *J. Chem. Phys.*, **18**, 1193–200 (*Sept.*, 1950).

The dielectric constant of a classical fluid, composed of spherically symmetric molecules with dipole-dipole interactions, is calculated by a method that leads to formulas previously derived by Yvon but is more direct and yields additional results. The relations of the formulas of Lorentz, Yvon, Kirkwood, and Böttcher to one another are clarified. An accurate calculation of the deviation from the Clausius–Mosotti formula requires knowledge of molecular distribution functions of various orders, but an approximate calculation is possible on the

basis of the radial distribution function alone. It is shown that the success of Böttcher's approximation is partly the result of an approximate cancellation of errors, and that a practically equivalent formula can be obtained by another method that lends itself more readily to improvement. The distinctive feature of the present calculation is the introduction of quantities $p_i^{(h)}$, the mean moment of molecule i when the positions of it and of $h-1$ other molecules are specified; Lorentz's formula corresponds to the approximation $p_1^{(2)} = p_1^{(1)}$, and other formulas to various approximate evaluations of the difference $p_1^{(2)} - p_1^{(1)}$. A.

537.226.2

289. Dielectric constants of non-polar fluids. II. Analysis of experimental data. W. F. Brown, Jr. *J. Chem. Phys.*, **18**, 1200–6 (*Sept.*, 1950).

Although the formulas of Part I (preceding Abstr.) do not apply strictly to actual gases and liquids, they suggest a possibly useful method of analysing data on the variation of dielectric constant ε with density d under high pressure at constant temperature. The method is to express $(\varepsilon+2)d/(\varepsilon-1)$ as a polynomial in d; the variable terms represent the deviation from the Clausius–Mosotti formula. This method has been tested, and compared with alternative procedures based on more specialized formulas, by analysis of data on CS_2 (Chang, Danforth) and on CO_2 (Michels and Kleerekoper). It is concluded that the proposed method is an efficient one for representing the data, that the values of the coefficients are consistent with the approximate values estimated from the simplified theory, and that there is no advantage in the use of more specialized formulas. The precision of present ε *v.* d data and of present knowledge of molecular distribution functions does not justify any more detailed conclusions. A.

537.226.2

290. Equivalence of temperature and frequency in dielectric measurements. K. H. Stark. Letter in *Nature, Lond.*, **166**, 436 (*Sept.* 9, 1950).

It is generally more convenient to determine the variation of dielectric constant of materials as a function of temperature than of frequency. Measurements at 50 c/s, 800 c/s and 50 kc/s show that the variation with temperature, between -100°C and -20°C, of the complex dielectric constant of a dielectric having a wide distribution of relaxation times (ketone-paraffin mixture) gives a circular arc plot which is equivalent to the plot obtained if frequency is varied. [See Abstr. 1344 (1941) and Sillars, *Proc. Roy. Soc. A*, **169**, 66 (1938)]. J. H. Mason

537.226.2

291. Dielectric constants of five gases at 9400 megacycles per second. J. A. Murphy and R. C. Raymond. Letter in *J. Appl. Phys.*, **21**, 1064–5 (*Oct.*, 1950).

Gases are H_2O, CO_2, CCl_4, NH_3 and C_3H_6O.

537.226.2

292. Dielectric loss and dielectric constant measurements in supercooled liquids. C. Dodd and G. N. Roberts. *Proc. Phys. Soc., Lond. B*, **63**, 814–18 (*Oct.*, 1950).

In order to provide further evidence in support of the structural change which takes place in a liquid when it is supercooled, measurements of dielectric loss at high frequencies and of dielectric constant have been made on various polar liquids. The evidence from the dielectric loss measurements is inconclusive but for the 4 liquids tested a significant discontinuity in the dielectric constant–temperature curve has been established at the melting point in each case. A.

537.226.2

293. The dielectric strength of aluminium oxide films. P. D. Lomer. Letter in *Proc. Phys. Soc., Lond. B*, **63**, 818–20 (*Oct.*, 1950).

537.226.2 : 536.48

294. A ferromagnetic Curie point in $KTaO_3$ at very low temperatures. J. K. Hulm, B. T. Matthias and E. A. Long. Letter in *Phys. Rev.*, **79**, 885–6 (*Sept.* 1, 1950).

537.226.2 : 536.48

295. The dielectric properties of some alkaline earth titanates at low temperatures. J. K. Hulm. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1184–5 (*Oct.*, 1950).

537.226.2 : 537.221

296. Static charges on dielectrics. B. Gross. *Brit. J. Appl. Phys.*, **1**, 259–67 (*Oct.*, 1950).

The author has previously shown [Abstr. 1897 (1949)] the permanent "homo" charge (of the same sign of the electrode) on electrets to arise from a transfer of charge from electrode to dielectric surface, often by discharges. Using the method of the demountable capacitor this discharge process of charge transfer has been investigated on polystyrene. By assuming that breakdown occurs at a given inception voltage, persists until the voltage drops to an extinction voltage, and affects the whole area of the electrode and dielectric surface, a quantitative explanation has been given of the variation of the charges on the electrode and on the dielectric surface when the voltage is varied in steps, in cycles, continuously and alternating. The explanations agree with the current theories of internal and external discharges. The extinction voltage is found to be not much less than the inception voltage, as opposed to the low extinction voltages sometimes or often encountered in internal discharges. A.

537.226.2 : 537.228.3

297. Electro-optical investigations on single crystals of the KH_2PO_4 group. M. Beck and H. Gränicher. *Helv. Phys. Acta*, **23** (*No.* 5) 522–4 (1950) *In German.*

Measurements were carried out of the factor e, relating the change of electric double refraction and the static field by $\Delta\lambda/\lambda = eE$, for large single crystals of ferro-electric RbH_2PO_4. This factor was found to obey a "Curie–Weiss law" above the transformation point (145·9°K). The spontaneous polarization below this temperature was measured and hysteresis curves obtained; the latter do not exhibit discontinuities of the type previously observed for KH_2PO_4. Similar measurements were also made with KH_2AsO_4 and $NH_4H_2PO_4$. E. P. Wohlfarth

537.226.2 : 541.64

298. The temperature-dependence of the dielectric constant of copolymers. P. P. Kobeko, G. P. Mikhailov and Z. I. Novikova. *J. Tech. Phys., USSR*, **19**, 116–19 (*Jan.*, 1950) *In Russian.*

The production of copolymers permits the study

of the influence of the polar and the non-polar parts of the macromolecule on the change of the dielectric permeability of the polymer at various temperatures. Together with the choice of appropriate concentration, one can obtain in a large temperature interval complete internal mutual compensation of the temperature-dependence of the capacity caused by the dipole and electronic polarization. This shows that the electrical and dipole polarization in macromolecules in an external field are, to a considerable extent, independent of each other. In this respect, they are externally similar to mechanical mixtures, though they differ physically from them in that they represent systems in which separate dipoles and non-polar components are chemically combined into uniform macromolecules.

BROOKHAVEN GUIDE TO RUSSIAN LITERATURE

537.226.2 : 541.64

299. Determination of the dipole moment of co-polymers. P. P. KOBEKO, G. P. MIKHAILOV AND Z. I. NOVIKOVA. *J. Tech. Phys., USSR*, **19**, 111–15 (*Jan.*, 1950) *In Russian.*

Conclusions: a method is developed for measuring the dipole moment of polar radicals of polymers in highly elastic states. It is shown that the system of copolymers of a polar with a non-polar component behaves, in respect to dielectric properties, analogously to Debye polar solutions. In the copolymer methyl vinyl ketone and methyl methacrylate with styrole, the dipole moment of polar radicals has been determined. The values of μ obtained from the experiments agree well with the one measured by the polar solutions method. This shows that, in polymers in a highly elastic state, the dipoles orient as in polar solutions of the same substances. The Debye theory can be extended not only to polar solutions but to elastic bodies, examples of which are polymers. Thus, the displacement of the dipoles can be explained by the same regularities independent of the magnitude of the molecule, the bond type, and the state of aggregation.

BROOKHAVEN GUIDE TO RUSSIAN LITERATURE

537.226.2 : 621.315.61 : 621.3.011.5

300. Ferroelectricity, domain structure, and phase transitions of barium titanate. A. VON HIPPEL. *Rev. Mod. Phys.*, **22**, 221–37 (*July*, 1950).

A summarizing account is given of research on $BaTiO_3$ in progress since 1943. The investigations have led to an understanding of the mechanism of ferroelectricity in the titanates and to discoveries such as the piezoelectric effect in the ceramics and the domain structure of the single crystals of $BaTiO_3$. The high dielectric constant, field strength and temperature sensitivity, and piezo-response of the $BaTiO_3$ dielectrics make them useful for numerous technical applications. A.

537.226.21.3

301. Optical method of measuring the dielectric permeability and loss of solid dielectrics in the centimetre range. L. L. ODYNETS. *J. Tech. Phys., USSR*, **19**, 120–5 (*Jan.*, 1949) *In Russian.*

The theory of the method was examined by measuring the transparency of a plane-parallel plate of a dielectric; the apparatus is described. Values were determined for two dielectrics at 5·5 cm wavelength with satisfactory precision.

BROOKHAVEN GUIDE TO RUSSIAN LITERATURE

537.228.1 : 534.121.1

Piezoelectric equations of state. *See Abstr.* 143

537.228.1 : 534.321.9

302. Piezoelectric crystals and their application to ultrasonics. W. P. MASON. *London, McMillan and Co.; New York, D. Van Nostrand Co.* (1950) 508 *pp.*

The experimental and theoretical work of the Bell Telephone Laboratories in developing piezo-electric crystals is described, much of the book being based on the author's previously published papers. Although one chapter deals with quartz, and another with Rochelle salt, interest is directed mainly to the crystals developed by the laboratories which include ammonium dihydrogen phosphate (ADP), potassium dihydrogen phosphate (KDP), monoclinic ferro-electric crystals such as dipotassium tartrate (DKT) and ethylene diamine tartrate (EDT), and the ceramic barium tartrate having an electrostrictive effect comparable with the largest piezo-electric effect. Chapters are included dealing with crystallographic systems, stresses, strains and thermal and electric relations, while an appendix shows the use of tensors for investigating the piezo-electric, electrostrictive, and mechanical properties of liquids and solids. A new theory is given of ferro-electricity in Rochelle salt, KDP, and barium tartrate. Three chapters deal with the use of ultrasonic methods for determining the properties of gases, liquids and solids. No mention is made of the more practical uses of ultrasonics such as flaw detection, investigations of emulsions, studies of density variation, medical treatment, etc. The electronic circuits used in modern ultrasonics are outlined but few details are given. Interest is directed largely to the measurement of attenuation and damping from which much information regarding the mechanical properties of materials can be inferred, and full details are given of this subject. The references are largely American apart from one or two classical British and foreign papers.

A. C. WHIFFIN

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 530.162 : 621.38

303. The theory and measurement of noise factor. R. J. YATES. *Marconi Instrum.*, **2**, 117–21 (*July–Aug.*, 1950).

Discusses the meaning and definition of noise factor and of noise bandwidth and briefly describes the principles and advantages of a diode (e.g. CV 172), operated in the temperature-limited region, as a noise source. C. F. BROCKELSBY

537.3 : 621.38

304. A high-level noise source for the audio-frequency band. H. D. HARWOOD AND D. E. L. SHORTER. *J. Sci. Instrum.*, **27**, 250–1 (*Sept.*, 1950).

An argon-filled thyratron is used to generate a continuous noise spectrum for a.f. testing. Large unwanted ultrasonic components are removed from

the output by a 20 kc/s low-pass filter, leaving a noise spectrum having constant power per c/s bandwidth over the a.f. range. Where required, a noise having constant power per octave bandwidth is produced by adding a weighting network. The output into 600 Ω is — 20 db with reference to 1 mW. The generator is mains-operated. A.

537.311.32

305. The temperature coefficient of a resistance of tin-oxide-coated electrically conducting glass between 1° and 300°K. D. N. LYON AND T. H. GEBALLE. Note in *Rev. Sci. Instrum.*, **21**, 769–70 (*Aug.*, 1950).

537.311.33

306. An oscillograph method for the investigation of barrier-layer properties of metal rectifiers. A. HOFFMANN. *Z. angew. Phys.*, **2** (*No.* 9) 253–9 (1950) *In German.*

The capacity of a barrier-layer rectifier may be used to estimate the barrier-layer thickness if Schottky's theory is applied. From current *v.* voltage oscillograms taken at various frequencies and with the rectifier working in various circuits the capacity may be estimated and hence the thickness of the layer determined. The method is applied to Se and Cu_2O rectifiers and its validity is confirmed by bridge measurements. C. A. HOGARTH

537.311.33

307. Unipolarity and applied voltage. F. TREY. *Z. angew. Phys.*, **2** (*No.* 9) 367–9 (1950) *In German.*

It is shown that rectification in compressed pellets of PbS is produced by a change in lattice structure due to heating of the PbS, the applied voltage producing a small distortion of the lattice during the process. The production of the necessary barrier layer by the diffusion of impurity atoms or defects is discussed in detail. G. F. J. GARLICK

537.311.33

308. Resistivity of semiconductors containing both acceptors and donors. C. S. HUNG AND V. A. JOHNSON. Letter in *Phys. Rev.*, **79**, 535–6 (*Aug.* 1 1950).

The experimental temperature/resistivity curve can be reproduced as the sum of curves due to scattering by lattice ions and by impurity ions. In the latter it is necessary to include in the density of impurity ions, in the formula of Conwell and Weisskopf [*Phys. Rev.*, **69**, 258 (1946); Abstr. 4079 (1950)], a No. (n) per cm^3 due (for an N sample with excess donor levels) to excitation from donor levels to the conduction bands. The temp.-dependence of n is found from the measured Hall coefficient. Good agreement is found for two N-type samples of Ge having different impurity densities. G. F. LOTHIAN

537.311.33

309. Electrical conductivity of ferromagnetic compounds of manganese of perovskite structure. J. H. VAN SANTEN AND G. H. JONKER. *Physica*, **16**, 599–600 (*Sept.*, 1950).

Tempered specimens of various mixed manganites, prepared by the controlled valency technique with a tempering process, were fitted with electrodes by the thermal decomposition of Ag lactate, and conductivity measurements were made at 3 kc/s as a function of temperature. Log σ *v.* $1/T$ curves show the normal linear form for well-conducting semiconductors above the Curie point, but at and below this temperature the curves show an anomaly. For certain ranges of composition the slope of the curves may change sign [see also Abstr. 5947 (1950)]. C. A. HOGARTH

537.311.33

310. The resistivity and Hall effect of germanium at low temperatures. C. S. HUNG AND J. R. GLIESSMAN. Letter in *Phys. Rev.*, **79**, 726–7 (*Aug.* 15, 1950).

537.311.33

311. Theory of resistivity and Hall effect at very low temperatures. C. S. HUNG. Letter in *Phys. Rev.*, **79**, 727–8 (*Aug.* 15, 1950).

537.311.33

312. Temperature dependence of the energy gap in germanium from conductivity and Hall data. V. A. JOHNSON AND H. Y. FAN. Letter in *Phys. Rev.*, **79**, 899 (*Sept.* 1, 1950).

537.311.33

313. Electrical conductivity of gray tin. J. T. KENDALL. Letter in *Proc. Phys. Soc., Lond. B*, **63**, 821–2 (*Oct.*, 1950).

A method of obtaining small crystalline specimens of gray Sn is described, and the electrical conductivity of 3 such specimens has been measured. It is concluded that gray Sn is an intrinsic semi-conductor and that in the equation $A = \exp(-\varepsilon/2k\tau)$, A is given by $\simeq 6\times10^4$ ohm^{-1} cm^{-1} and ε by 0·098 eV for the higher temperature end of the conductivity curve (above ~ 160°K). The value of ε thus fits well into the series of values for Si, Ge, and Sn, i.e. 1·12, 0·75, and 0·1 eV respectively. C. A. HOGARTH

537.311.33 : 530.162

314. A theory of contact noise in semiconductors. G. G. MACFARLANE. *Proc. Phys. Soc., Lond. B*, **63**, 807–14 (*Oct.*, 1950).

The low-frequency noise is attributed to the random movement of adsorbed ions on the surface of a semi-conductor from which an electron current is being drawn. Emission of electrons is assumed to take place only at localized patches on the surface and the adsorbed ions are assumed to give rise to a Schottky barrier layer, in which the potential maximum is linearly related to the concentration of ions. Diffusion of the ions over the surface gives rise to random fluctuations in the concentration of ions in a patch which results in random fluctuations in the height of the potential barrier and the emission current. It is shown that for a circular patch the spectral power density of the noise current varies with mean current j_0 and frequency f as $j_0^2 f^x$ over a small range of frequency and that x varies monotonically from $-0{\cdot}75$ at the lowest frequencies to $-1{\cdot}125$ at the highest frequencies. It is also shown that for a long thin rectangular patch the index x varies monotonically from $-0{\cdot}5$ to $-1{\cdot}5$ as the frequency is increased from zero. The dependence of the noise power density on temperature is also discussed. A.

537.311.33 : 539.185

315. Thermal equilibrium in neutron-irradiated semiconductors. J. H. CRAWFORD, JR. AND K. LARK-HOROVITZ. Letter in *Phys. Rev.*, **79**, 889–90 (*Sept.* 1, 1950).

537.312.5

316. Investigations into the spectral sensitivity of selenium photocells. H.-G. SANNER. *Ann. Phys., Lpz.*, **7** (*No.* 7–8) 416–19 (1950) *In German.*

A new type of Se photocell utilizes a Cd intermediate layer between the Se and the transparent precious metal top layer. The spectral sensitivity extends into the near infrared to the same limit (9 000 Å) as before, only that the sensitivity between 7 000 and 9 000 Å is significantly increased showing a second peak at 7 250 Å (first max. at 5 400 Å). The sensitivity of the new cell in the near u.v. and violet region is greatly, in the blue region moderately, reduced. An explanation is offered on the basis of the Cd–Se molecules lodging in the lattice of the barrier layer and acting as centres of disturbance. The position of the second max. seems to be governed by the physical nature of these centres, and its amplitude by the number of the centres of disturbance. It is suggested that by using appropriate materials for the intermediate layer it must become possible to sensitize a Se photocell for a predetermined spectral range. The absorption of the near u.v. energy takes place in the Cd-layer. If the incident radiation centres around 7 000 Å which is the position of the min. spectral sensitivity the phenomenon of fatigue becomes apparent. W. SUMMER

537.312.5

317. The photo-effect of alkali-germanium compounds. N. SCHAETTI AND W. BAUMGARTNER. *Helv. Phys. Acta*, **23** (*No.* 5) 524–8 (1950) *In German.*

Depending on the alkali, the long wave limit of the spectral sensitivity lies between 5 000 and 7 000 Å with the maximum well below 4 000 Å. All compounds investigated so far are Ag-activated. The quantum efficiency varies by a factor of 50 depending on the alkali and by a factor of 10 for Ag-activated Ge-compounds. The limits and general character of the light absorption are similar to the spectral sensitivity of the Ge cells. The amount of Ag in the alkali-Ge compound controls the surface resistance of the layer. W. SUMMER

537.312.5 : 535.14

318. Photoelectric emission from *F*-centers in KI. L. APKER AND E. TAFT. *Phys. Rev.*, **79**, 964–6 (*Sept.* 15, 1950).

F-centres were produced in thin evaporated layers of KI by u.v. irradiation or by electron bombardment. Photoelectric emission became measurable for $h\nu = 2{\cdot}5$ eV and increased to a plateau value near 10^{-4} electron/quantum at 4 eV. Yields rose further to a sharply peaked value about 20 times higher at 5·66 eV. This point is practically coincident with the first optical absorption maximum for pure KI as measured by Fesefeldt. The peak shifted with temperature in the same way as the optical absorption. The yield was roughly proportional to the absorption constant. Below 5 eV, the emission was attributed to direct ionization of *F*-centres. The enhanced yields at the peak were tentatively ascribed to ionization of centres by excitons produced in the optical absorption. A.

537.312.62

319. Superconductivity of copper sulphide. W. BUCKEL AND R. HILSCH. *Z. Phys.*, **128** (*No.* 2) 324–46 (1950) *In German.*

The temperature variation of resistance of CuS specimens produced with various heat treatments and various amounts of impurity has been studied. The superconducting transition point was found to be lowered by the addition of any of the impurity atoms tried. A typical rate of lowering was 0·25°K for addition of 0·01% Fe. It is suggested that superconductivity is associated with a certain degree of disorder. D. SHOENBERG

537.312.62

320. Superconductivity of vanadium. A. WEXLER AND W. S. CORAK. Letter in *Phys. Rev.*, **79**, 737–8 (*Aug.* 15, 1950).

537.312.62

321. Debye modes and superconductivity. W. BAND. Letter in *Phys. Rev.*, **79**, 739–40 (*Aug.* 15, 1950).

537.312.62

322. Superconductivity in tin–germanium "alloys". R. P. HUDSON. Letter in *Phys. Rev.*, **79**, 883 (*Sept.* 1, 1950).

537.312.62

323. Isotope effect and lattice properties in superconductivity. K. F. HERZFELD, E. MAXWELL AND R. B. SCOTT. Letter in *Phys. Rev.*, **79**, 911 (*Sept.* 1, 1950).

537.312.62

324. Superconductivity of lead sulphide, selenide and telluride. J. DARBY, J. HATTON AND B. V. ROLLIN. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1181–2 (*Oct.*, 1950).

537.312.62

325. Theory of the superconducting state. I. The ground state at the absolute zero of temperature. H. FRÖHLICH. *Phys. Rev.*, **79**, 845–56 (*Sept.* 1, 1950).

In Bloch's theory of electronic conductivity the scattering of electrons by lattice vibrations is connected with the absorption or emission of vibrational quanta. As in field theories this gives rise to a self-energy which can be calculated by application of perturbation theory. The most interesting term as a result of the Pauli principle has the form of an interaction between electrons in momentum (k) space. The interaction between two electrons whose energy difference is small compared with their energy is, roughly speaking, repulsive for equal energies but different directions of $\mathbf{k}$, and attractive otherwise. If strong enough it leads in the ground state to a distribution in momentum space different from the normal (Fermi) distribution. In this case excited states exist in which some (ΔZ) electrons in view of their interaction in momentum space are concentrated in a narrow region in $\mathbf{k}$-space. These states are stable in the sense that it requires energy to remove one of the electrons. Their energies are higher than the ground state by a term proportional to $(\Delta Z)^2$. For the above-mentioned ground state (identified with the superconducting state) to be realized it is found that $pnv^{5/3}(1/n =$ atomic volume; $v =$ number of free electrons per atom) must exceed a value depending on universal constants only. If $v = 1$ is assumed, all monovalent metals except Li do not satisfy the required condition, but most super-

conductors do. The energy difference between the normal and the superconducting state at absolute zero is about ms^2 (s = velocity of sound) per electron. It has thus the correct magnitude corresponding to a temperature of a fraction of a degree absolute. A.

537.312.62 : 536.212.2

326. Heat flow in superconductive alloys. K. MENDELSSOHN AND J. L. OLSEN. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1182–3 (*Oct.*, 1950).

537.312.62 : 538.3

327. Electromagnetic forces on a superconductor. W. V. HOUSTON AND N. MUENCH. *Phys. Rev.*, **79**, 967–70 (*Sept.* 15, 1950).

Measurements of the eddy current damping of the rotational oscillations of a Sn sphere suspended in a magnetic field from a torsion fibre give the expected results as a function of the magnetic field and the conductivity as long as the Sn is a normal conductor. Below the transition temperature, however, the damping torque becomes less than 10^{-5} times its value in the normal state and no changes in period are observed except those attributable to residual frozen-in moments. A.

537.312.9 : 539.4.016 : 536.48

328. Change of resistivity by cold working at liquid-air temperature. J. MOLENAAR AND W. H. AARTS. Letter in *Nature, Lond.*, **166**, 690 (*Oct.* 21, 1950).

537.321

329. On the resistance of an electrically heated conductor and the determination of the Wiedemann–Franz number. H. DIESSELHORST. *Abh. Braunschw. Wiss. Gesell.*, **1**, 14–24 (1949) *In German.*

537.322.1

330. Improved theory of electrothermic refrigeration. P. O. GEHLOFF, E. JUSTI AND M. KOHLER. *Abh. Braunschw. Wiss. Gesell.*, **2**, 149–64 (1950) *In German.*

The use of the Peltier effect for refrigeration is discussed. The assumptions and results of the theory of Altenkirch (1912) in which, under idealized conditions, the practical use of the Peltier effect is considered, are briefly stated and discussed. Altenkirch's theory, which is concerned with thermocouple components of cylindrical form only, is then extended to other non-cylindrical forms. It is shown that even a small contact resistance at the cold junction has a considerable harmful effect on the attainable cooling and on the efficiency of the electrothermic process. It is concluded that with modern materials electrothermic refrigeration should now be practically possible. S. WEINTROUB

537.362

331. Research on electrical osmosis. L.-H. COLLET. *Publ. Sci. Min. Air France* (*No. N.T.* 34) 62 *pp.* (1950) *In French.*

The history of electrical osmosis is first discussed, after which experiments are described which invalidate the double-layer theories of Quincke and of Helmholtz and indicate electrolysis as the true cause. Data on the passage of electrical currents through porous membranes, derived from new techniques which promise excellent quantitative results, establish that the chemical nature of partitions has no role, but that the membrane should be considered as an integral part of the container. It is shown that electrical osmosis is explicable in terms of known phenomena and requires no new hypothetical concept. The viewpoint now submitted offers an insight, even if complex, into the structure of electrolysable solutions. An appendix deals with the utilization of porous membranes in electrical osmosis. There are 21 diagrams and 37 references. H. H. HODGSON

537.363

332. The cataphoresis of spherical, solid non-conducting particles in a symmetrical electrolyte. F. BOOTH. *Proc. Roy. Soc. A*, **203**, 514–33 (*Oct.* 24, 1950).

A theoretical analysis is given of the motion of solid non-conducting charged spheres through symmetrical electrolytes, under the action of an applied electric field. It is shown that the steady velocity of translation U may be written in the alternative forms

$$U = \sum_1^\infty c_\nu Q^\nu = \sum_1^\infty d_\nu \zeta^\nu$$

where Qe denotes the charge on a sphere and ζ the zeta-potential; the coefficients c_ν and d_ν are proportional to the applied field strength and depend upon the radius of the particle and the concentrations, valencies and mobilities of the ions in the electrolyte. A general method is given for calculating the c_ν and d_ν and the first 4 coefficients of each series found explicitly. Some quite general properties of the c_ν are also deduced. It is shown that under certain conditions, the terms of the series for U, apart from the first, are of considerable importance and must be taken into account in estimating ζ from U. A.

537.363

333. The electroviscous effect for suspensions of solid spherical particles. F. BOOTH. *Proc. Roy. Soc. A*, **203**, 533–51 (*Oct.* 24, 1950).

The increase of the effective viscosity due to the surface charge and the ionic double layer surrounding the particles is determined by a modification of Einstein's method for the calculation of the viscosity of solid suspensions. The effective viscosity may be expressed in the form

$$\eta = \eta_0\left\{1 + 2{\cdot}5(v/V)\left(1 + \sum_{r=1}^{\infty} a_r Q^r\right)\right\},$$

where η_0 is the viscosity of the electrolyte, v the volume of suspension in volume V of solution and Qe is the charge on each particle. It is shown that $a_1 = 0$ and a_2 is determined explicitly. It is found that the electroviscous contribution to η, for a given charge Q, tends to increase as the thickness of the double layer increases. When the thickness of the double layer is small compared with the radius of the particle the effect vanishes. A.

537.363 : 541.135.6

334. The polarization of electrodes in the electrophoresis and electrolysis of thorium oxide and thorium nitrate. G. MESNARD. *Vide*, **5**, 866–9 (*July–Sept.*, 1950) *In French.*

It has been found in the electrophoresis of ThO_2 that the current decreases due to the polarization of the deposited layer. One electrode is a thin filamentous W structure, while the other electrode is a relatively large Ni cylinder arranged co-axially with

the W filament. If the current in the electrolyte flows from the cylinder to the wire the latter becomes polarized. If the direction of flow is reversed the cylinder is polarized. Spontaneous depolarization is weak. The results vary slightly according to whether the electrolyte is an aqueous or alcoholic solution of $Th(NO_3)_4$. W. SUMMER

ELECTRIC DISCHARGES 537.52

537.521.7

335. A new type of discharge in magnetic fields. F. EHRENHAFT, R. F. K. HERZOG, M. J. HIGATSBERGER, F. P. VIEHBÖCK AND P. M. WEINZIERL. *Acta Phys. Austriaca*, **4** (*No.* 1) 129–32 (1950) *In German.*

The two pole pieces of an electromagnet (producing a field of 5 000 gauss in the gap) are in electrical contact and serve as cathode; a surrounding cylinder acts as anode, and a d.c. voltage of 300 to 600 is applied. If the pole pieces are treated with Apiezon grease, sparks are seen to travel in the direction of the magnetic lines of force. The discharge is not entirely due to secondary electrons, as no tracks are seen which would be formed by the secondary ions. Further experiments are in progress. N. CORCORAN

537.521.7

336. The development of electrical discharge in long gaps. V. S. KOMELKOV. *Izv. Akad. Nauk, SSSR, Otdel Tekhn. Nauk, No.* 6, 851–65 (*June*, 1950) *In Russian.*

In this study of the "leader" stage of discharge Meek's theory of discharge as modified by Szpor and Bruce is reviewed critically. The dimensions of leader channels and potential gradients and current densities in them are determined from photographs and oscillograms. The leader channel (which has the properties of an arc channel) is surrounded by an ionized region which consists of streamers of low luminosity. The charge carried into the gap by the leader is mainly concentrated in the space surrounding the leader. This observation calls for amendment of existing theories of main discharge. A qualitative mechanism of leader development is suggested. Leader discharge in lightning is considered to be a retarded process in which ionization is periodically weakened and a screening space charge is formed. As the channel potential steadily increases the leader develops again. An expression is given relating the average velocity of the leader to the current in it. W. R. STOKER

537.523.5

337. The temperature field of a free-burning carbon arc. J. SPERLING. *Z. Phys.*, **128** (*No.* 2) 269–78 (1950) *In German.*

Describes a Schlieren technique for measuring radial variations of gas temperature in arcs, and discusses in detail the analysis of the results. Currents varied from 2·9 to 20 A and the gas temp. was 4 000°K at about 4 mm from the discharge axis, falling to ~ 200°K at ~ 1 cm. Axial measurements of temp. were not made. J. D. CRAGGS

537.523.5

338. The field of flow near a free-burning carbon arc. W. HAGENAH. *Z. Phys.*, **128** (*No.* 2) 279–88 (1950) *In German.*

The convection currents near a C arc were studied by ciné photography of C particles moving in a dark field near the arc column. From the results and a knowledge of the spatial temperature variations, the connective heat loss from the arc channel may be found, and compared with the electrical energy input. J. D. CRAGGS

537.523.5

339. Checking the theory of arcs: the effective molecular cross-section for air at high temperatures. H. MAECKER. *Z. Phys.*, **128** (*No.* 2) 289–94 (1950) *In German.*

The radial variations of gas temperature for certain arcs in open air were calculated by a new method and compared with recent exptl. data. The agreement was not good due, it is suggested, to a neglect of the temp. variations of the molecular cross-sections. Hence since knowledge of these variations are lacking the arc theory cannot be checked, but the observed results can be used to calculate the temp. variations of the cross-sections. J. D. CRAGGS

537.525

340. An explanation of the influence of the frequency of the exciting potential on Joshi effect. G. V. BAKORE. *Indian J. Phys.*, **24**, 291–5 (*July*, 1950).

An increase in the supply frequency increases the positive space-charge density which enhances the intensity of ionization by collision in the discharge space and consequently reduces the "threshhold" potential V_m. This high initial positive space-charge in dark reduces, in effect, the negative space-charge formed under light, which according to Joshi's theory should diminish the light-effect as observed. An increase in the supply frequency decreases the high-frequency components which, according to Joshi, leads to a dimunition of the Joshi effect. Other theories of Joshi effect are also discussed in this connection. A.

537.525

341. A note on Joshi effect. R. AHMED AND P. S. GILL. Letter in *Curr. Sci.*, **19**, 206–7 (*July*, 1950).

A brief note, outlining how the Joshi effect may be explained in terms of additional ionization produced in a discharge by low-energy visible radiation if (*a*) the major portion of gas amplification takes place near the anode and (*b*) a strong space charge layer at the cathode decreases the potential gradient at the anode. J. D. CRAGGS

537.525,2

342. Influence of cold emission on spark lag in compressed gases. A. BOULLOUD. *C.R. Acad. Sci., Paris*, **231**, 514–16 (*Sept.* 4, 1950) *In French.*

Comparison of spark lags in compressed air and CO_2 shows that for electric fields of the order of 20 kV/mm, the mean statistical time-lag depends on the metal of the cathode. This effect must be attri-

buted to the cold emission of electrons in numbers sufficient to dispense with external sources of ionization in measurements of sparking potential. A.

537.525.5

343. Resonance phenomena in controlled low pressure mercury arcs, using ultra short waves. A. HAUG. *Z. angew. Phys.*, **2**, 323–9 (*Aug.*, 1950) *In German.*

Refers to recent work on the control, with low frequency a.c., of l.p. arcs, briefly describes the control action in terms of the sheaths (space charge layers) at the control electrodes, and proceeds to describe, in detail, expts. using m and dm radiation, i.e. control voltages having frequencies corresponding to these wavelengths. Oscillations, some of them of the well-known Langmuir–Tonks type, were found and are discussed. J. D. CRAGGS

537.525.5

344. Note on the electron velocity distribution in low voltage arcs. M. S. B. CHAGHTAI. *Proc. Phys, Soc., Lond. B*, **63**, 768–72 (*Oct.*, 1950).

An analysis has been made of a large number of hot-cathode, low-voltage, arc-type discharges in Hg vapour and H at low pressure by the cold probe methods of Langmuir and Mott-Smith. It has been verified that the space potential in the plasma near the filament is positive relative to anode potential, and it has been shown that consistent data for the space potential and concentrations of the slow (ultimate) electrons are obtainable from analyses of probe characteristics in both retarding and accelerating fields for electrons. The way in which the fast (primary) electrons develop a random motion has been traced by progressively confining them within the main discharge, firstly by using a cylindrical gauze anode with open ends, secondly by using a solid anode with open ends and lastly by using a solid anode with end caps. A.

537.525.5

345. Hot-cathode arcs in cesium vapor. R. K. STEINBERG. *J. Appl. Phys.*, **21**, 1028–35 (*Oct.*, 1950).

A hot-cathode arc in Cs vapour has been studied by the use of a plane Langmuir probe to investigate the potential distribution, electron temperature and electron density in the plasma. The range of arc currents and vapour pressures over which satisfactory probe measurements may be made are determined. In some cases it was possible to maintain the discharge with a total arc drop of less than the ionization potential of Cs (3·87 V). Potential "humps" along the arc are shown to be absent, and ionization by the high-energy electrons of a Maxwellian electron velocity distribution is found unsatisfactory as a possible mechanism for positive ion production in the arc. The mechanism of successive electron collisions can account for the observed ionization on the assumption that the effective lifetime in the excited state is increased by the process of the imprisonment of resonance radiation. A.

537.525.5 : 537.525.8

346. Properties of the positive column at low pressures. T. WASSERRAB. *Z. Phys.*, **128** (*No.* 2) 312–23 (1950) *In German.*

A study of the properties of low-pressure discharge plasmas for the cases when m.f.p.'s are $\gg$ tube radius, or $\ll$ tube radius. The relations between electron temperature, degree of ionization, longitudinal field strength, tube radius and pressure, etc., are discussed. Finally, de-ionization processes are described. J. D. CRAGGS

537.525.72

347. Development of the low pressure electrodeless discharge in a high-frequency electric field. G. FRANCIS AND A. VON ENGEL. Letter in *Proc. Phys. Soc., Lond. B*, **63**, 823–4 (*Oct.*, 1950).

537.525.8

348. On the mechanism of the canal-ray discharge. D. KAMKE. *Z. Phys.*, **128** (*No.* 2) 212–38 (1950) *In German.*

Describes in considerable detail a series of expts. on the structure, particularly at the cathode, of the canal-ray discharge. The exptl. tubes are fully described, with the Faraday cylinder arrangement used to measure the canal rays. The results provide data for H_2, N_2, Ne, He, O_2 and A discharges ($V \sim 30$ kV, $I \sim$ a few milliamps.). Some 18 pages are then devoted to a discussion of the theory of canal-ray discharges. J. D. CRAGGS

537.525.8

349. Electron conductivity and mean free paths. F. P. ADLER AND H. MARGENAU. *Phys. Rev.*, **79**, 970–1 (*Sept.* 15, 1950).

Mean free path and electron density are calculated from measurements on the complex conductivity of a discharge. Formulas based on two alternative assumptions are tested against experimental facts; one is constancy of mean free path (independence of electron velocity), the other is constancy of mean free time. A.

537.525.8 : 537.565

350. Ambipolar diffusion in neon. M. A. BIONDI. Letter in *Phys. Rev.*, **79**, 733–4 (*Aug.* 15, 1950).

Refers to previous work [Abstr. 4815 (1949)] on ambipolar diffusion and electron/ion recombination in various gases, and presents new data, taken with an improved apparatus, for neon. The vacuum technique enabled spectroscopically pure neon to be used. The product $D_a p$ (ambipolar diffusion coefficient × pressure) was 115 ± 10 cm^{2}sec^{-1} mm. Hg at a temp. of 300°K. J. D. CRAGGS

537.525.8 : 538.566.2

351. A microwave method of measurement of electron concentrations in the plasma of a glow discharge. R. HONERJÄGER AND E. SCHULZ–DU BOIS. *Naturwissenschaften*, **37** (*No.* 15) 358–9 (1950) *In German.*

Describes a technique, using a coaxial line as a resonant cavity, whereby electron concentrations in gaseous discharges may be deduced from observations of the detuning caused in the cavity by a discharge. The wavelength range was about 8·5 — 12·8 cm; results for l.p. discharges in unpurified air ($p \simeq 0{\cdot}6$ mm Hg) are given. J. D. CRAGGS

537.525.9 : 537.562

352. Effects of plasma boundaries in plasma oscillations. D. BOHM AND E. P. GROSS. *Phys. Rev.*, **79**, 992–1001 (*Sept.*, 1950).

It is first shown that an electron taking part in a travelling plasma oscillation will be reflected at a

sheath of infinitesimal thickness with velocity appropriate to the oscillation travelling in the reverse direction. This means that standing waves may be built up without loss at the sheaths. This approach is extended to sheaths where a finite time of penetration is necessary before reflection occurs and also to the case of reflection at metallic electrodes. In both cases expressions for the damping are derived and it is concluded that for low pressure discharges damping resulting from imperfect reflection from electrode sheaths may be comparable with collision damping but that damping arising from conducting electrodes is unimportant. The excitation of the plasma by sharp beams is considered briefly and expressions are derived for the energy transfer of a beam to growing and to stationary amplitudes. A detailed analysis is given of the bunching which occurs with irregular geometry and of the Merrill and Webb experiments. A.

537.527.4

353. The light emission from high-current spark discharges. I. G. GLASER. *Optik*, **7** (*No.* 1) 33–53 (1950) *In German.*

Deals in great detail with the emission spectra obtained with discharges of the flash-tube type, i.e. sparks obtained with the discharge of large capacitances (0·01–5 μF, 2–15 kV in the present work) through gases at high pressures (1–17 atmos. was the range covered). Details of the electrical and optical arrangements are given and results obtained with Kr, Xe, A, H_2, N_2, CO_2 and Hg are shown in graphical and tabular form. The paper is not self-contained and another part will give the bibliography. J. D. CRAGGS

537.527.4

354. The light emission from high-current spark discharges. II. G. GLASER. *Optik*, **7** (*No.* 2) 61–90 (1950) *In German.*

Describes expts. on the emission spectra of high-pressure sparks in various gases, using oscillatory discharges. The effects of variations in circuit parameters are investigated; the gases used comprised Kr, H_2, CO_2 and N_2. J. D. CRAGGS

537.527.5

355. The effective ionization potential in high pressure mercury discharges. R. BORCHERT. *Ann. Phys., Lpz.*, **7** (*No.* 7–8) 321–31 (1950) *In German.*

Discusses the change in effective ionization potential for a gas in which the degree of ionization is appreciable, and gives a theoretical treatment. For a h.p. Hg discharge, V_i changes by about 0·2 V up to 20–30 atmos. pressure and, in order to obtain a shift of 0·5 V, loadings of > 100 kW/cm^3 are necessary. J. D. CRAGGS

537.527.5

356. The origin of the continuum in the high pressure mercury discharge and the value of its mean excitation voltage. R. BORCHERT. *Ann. Phys., Lpz.*, **7** (*No.* 7–8) 332–40 (1950) *In German.*

Whereas the continuum in Hg discharges at medium pressures ($\sim$ 8–10 atm.) consists, it is stated, of roughly equal amounts of recombination and molecular collision radiation, and despite the quadratic relation between the intensity of the latter and pressure, at higher pressures the former predominates. This is due to increasing electron concentration caused in turn by increase of temp. and the liberation of electrons from upper energy levels. The change in ionization potential due to the latter cause is small. Detailed exptl. data are given and discussed. J. D. CRAGGS

537.527.5

357. Remarks on the work of G. Schmitz: "On the breadth of wall-stabilized arc discharges." O. KOCH. *Z. Phys.*, **128** (*No.* 2) 180–2 (1950) *In German.*

See Abstr. 6524 (1950). A note giving criticisms, based for example on axial temp. values and temp. variations of thermal conductivity, of the above paper. J. D. CRAGGS

537.527.5

358. Reply to the foregoing remarks of O. Koch. G. SCHMITZ. *Z. Phys.*, **128** (*No.* 2) 183–4 (1950) *In German.*

See preceding Abstr. A short note, in reply to the criticisms given in the above paper by O. Koch.

537.529

359. On the mechanism of electrical breakdown of solid dielectrics. D. V. ZERNOV. *Izvestia Akad. Nauk, SSSR, Otdel Tekh. Nauk*, *No.* 6, 866–72 (*June*, 1950) *In Russian.*

Modern theories of breakdown in solids are largely concerned with elucidating changes in conductivity with change of field in the early stages of breakdown; they do not account fully for the observed effects. As is shown by comparing it with breakdown of a compressed gas, the breakdown of solids should not be considered from this angle but rather as resulting from impact ionization of electrons linked in the lattice. Electron processes in very thin dielectrics display effects analogous with corona in compressed gas; the conditions of transition from corona to streamer discharge is the same in both cases. Despite this analogy it is not possible to increase the breakdown of solids by means effective in gas (diminution of the product of pressure and distance in the LHS of Paschen's curve) because this would correspond to reduction in the dielectric thickness to such an extent that quite a low voltage drop would produce heavy currents by the direct influence of the strong field on electrons and not by impact ionization. W. R. STOKER

X-RAYS 537.531

537.531 : 548.734.3

360. Single wave-length X-rays for powder diffraction. L. K. FREVEL AND P. P. NORTH. *J. Appl. Phys.*, **21**, 1038–9 (*Oct.*, 1950).

W L_α radiation filtered through a Cu–Zn foil is essentially monochromatic and has the advantage over filtered Cu K_α or Mo K_α radiation in that the W L_{α_1} line is approximately 10 times as intense as the W L_{α_2} line. Moreover the comparatively wide $\Delta\lambda$-spread (W L_{α_2} — W L_{α_1}) results in very sharp powder lines at those Bragg angles where the Cu K_α doublet or Mo K_α doublet is unresolved. A.

537.531.08 : 614.8

361. A calibrated roentgen-ray film badge dosimeter. E. Tochilin, R. H. Davis and J. Clifford. *Amer. J. Roentgenol. Radium Ther.*, **64**, 475–88 (*Sept.*, 1950).

An X-ray film badge dosimeter is described which allows quantitative interpretation of the stray dose received from X-rays of effective energy 15–150 kV. Two kinds of American dental film were calibrated. The film is Pb-backed, and faced with a 3-step Cu–Al echelon with a 4th unfiltered window. A discussion on the requirements and limitations of film badge indicators is presented. Tables are given in which the ratio of densities between two adjacent shields determines a factor, which, when multiplied by the net density under one of the shields, gives the dose received directly in roentgens. Quality of direct or scattered X-radiation can also be measured with this film badge. Processing of the film is standardized by developing a pre-exposed comparator film for various times until a density of $1{\cdot}5 \pm 0{\cdot}15$ is obtained. Developing film badges for this time then produces blackening independent of temperature and the type of developer used. D. V. MABBS

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 621.385.032.21

362. Transit-time phenomena in electron streams. D. K. C. MacDonald. *Phil. Mag.*, **41**, 863–72 (*Sept.*, 1950).

Previous work [Abstr. 5461 (1949)] is continued; an electron stream with thermal velocities having a given density-modulated sinusoidal signal is considered. There is an alteration with transit-time of the amplitude and phase of this signal. This variation and that of the space-charge reduction factor are analysed under two potential laws of physical interest: (1) linear, (2) the Langmuir–Child potential law. The theory is compared with experimental results.

L. S. GODDARD

537.533.72

363. Note on stability of electron flow in the presence of positive ions. J. R. Pierce. Letter in *J. Appl. Phys.*, **21**, 1063 (*Oct.*, 1950).

537.533.72

364. Remark on an aberration-phenomenon in electrostatic lenses. "Kidney effect." E. Bas-Taymaz. Letter in *J. Appl. Phys.*, **21**, 1064 (*Oct.*, 1950).

537.533.72

365. Ring focus in a thin magnetic-lens beta-ray spectrometer. J. M. Keller, E. Koenigsberg and A. Paskin. *Rev. Sci. Instrum.*, **21**, 713–21 (*Aug.*, 1950).

The paths of electrons in a thin magnetic-lens type of spectrometer are described by a non-linear differential equation. The equation was numerically integrated to obtain a set of electron trajectories originating from a point source on the axis of the instrument. Trajectories for off-axis sources were approximated. On the basis of these trajectories, the location and some properties of ring focus were studied. Theoretically calculated line shapes are compared for axial and ring focus. For reasonable values of resolution, the transmission of the spectrometer would be roughly doubled by performing the momentum discrimination by a ring-focus baffle instead of by a small counter on the axis. A.

537.533.72 : 537.534 : 621.385.1.029.6 : 621.384.6

366. Graphical representation of particle trajectories in a moving reference system. M. Garbuny. *J. Appl. Phys.*, **21**, 1054–6 (*Oct.*, 1950).

A graphical method is derived for the analysis of microwave electron tubes, ion accelerators, etc., which refers particle positions and velocities to a moving reference system. If the forces are dependent on time only, the trajectories are transformed into straight lines. For inhomogeneous fields an approximation procedure applies. A brief treatment of the transit time phenomena in cavity triodes is outlined as an example. A.

537.533.72 : 539.163.2

367. The design of a magnetic focusing coincidence spectrometer. C. M. Fowler and R. G. Shreffler. *Rev. Sci. Instrum.*, **21**, 740–6 (*Aug.*, 1950).

The primary function of the spectrometer is that of determining whether or not two different radiations from a radioactive sample are in the same branch of the nuclear decay scheme. Although the instrument is designed primarily for studies between conversion electron groups, it is also suitable for studies between conversion groups and beta-spectra. A feature of the instrument is its extraordinarily good coincidence resolving power. A.

537.533.72 : 621.385.833

368. Some crossover properties in the electron immersion objective. L. Jacob. *J. Appl. Phys.*, **21**, 966–70 (*Oct.*, 1950).

It was earlier [*Phil. Mag.*, **39**, 400–8 (*May*, 1948) Abstr. 2794 B (1948)] established that the lens field between the cathode and crossover can be represented by a simple function $V = \sin hkz$, so that the main properties of the paraxial "crossover" (or minimum section of the beam) can be determined as a first approximation in terms of "A" and "k." The distance of the crossover works out at $8\pi/3k\sqrt{3}$; its potential is $A\exp(8\pi/3\sqrt{3})$; and the angle of the beam is simply proportional to "k." The radius of the crossover is then $2/k \exp[-(2\pi/3\sqrt{3})] \cdot \tan\theta$ for electrons of initial velocity "A," where θ is the angle of emission within the paraxial limit. The differential analyser was also used to obtain the correct solution for the trajectory equation from the field plots for different systems, and shows that the simple theory gives an adequate approximation for design purposes. A.

537.533.72 : 621.385.833

369. Space-charge effects in electron beams and their reduction by positive ion trapping. E. G. Linder and K. G. Hernqvist. *J. Appl. Phys.*, **21**, 1088–97 (*Nov.*, 1950).

The spread of electron beams caused by space-charge forces is discussed. Under certain conditions ions formed from the residual gas may be trapped in the beam. An equilibrium condition may be established in which the electron and ion densities are

equal, and then space-charge forces will be neutralized. Under these conditions high current densities may be produced at low voltages. A theory of ion trapping is discussed, and the equilibrium condition is formulated. Experimental data obtained by the application of microsecond pulses to the beam are presented. This technique is described, and its advantages and possibilities are mentioned. Data are given on beam spread as function of current, voltage and pressure. Data on the improvement due to ion trapping are included. An increase of current density by a factor of 30 was observed with the structures tested. Results are included on ion build-up time as a function of pressure, and on beam noise and stability in the presence of trapped ions. A.

537.533.72 : 621.385.833

370. A small electron microscope. J. H. Reisner and E. G. Dornfeld. *J. Appl. Phys.*, **21**, 1131–9 (*Nov.*, 1950).

The instrument has a resolution of 100 Å, yet is small enough to be mounted on a desk or laboratory table. Magnetic lenses are energized by permanent magnets. An accelerating voltage of 50 kV is varied over a narrow range to provide means of focus. Images may be photographed on 2×2 plates. Plates may be changed in a minute, and specimens in 15 sec. Direct magnifications of 1 500, 3 000 and 6 000 are possible depending on pole pieces used. Photographic images may be enlarged up to 10 times. The instrument is free of X-radiation and completely interlocked and provided with short-circuiting devices for h.v. protection. A.

537.533.74

371. The scattering of electrons in thin films. L. M. Biberman, E. N. Vtorov, I. A. Kovner, N. G. Sushkin and B. M. Yavorskiĭ. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 4) 519–20 (1949).

537.533.74

372. Polarization of electrons. K. Shinohara and N. Ryu. *J. Phys. Soc., Japan*, **5**, 119–24 (*May–June*, 1950). For abstract see Abstr. 7072 (1949).

537.533.74 : 530.145

373. High energy elastic scattering of electrons on protons. M. N. Rosenbluth. *Phys. Rev.*, **79**, 615–19 (*Aug.* 15, 1950).

The theory is discussed in detail. A formula is given for the cross-section. This formula contains certain parameters which depend on the action of the virtual photon and meson fields. In particular, curves have been calculated on the assumption of scalar and pseudoscalar meson theory. While these perturbation theory calculations are not very trustworthy, and the results depend on the choice of coupling constants, it is felt that qualitative features can be checked with experiment. It is concluded that at low relativistic energies ($E < 50$ MeV) the experiment provides a valuable check on quantum electrodynamics. At higher energies it should yield data on the nature of the meson cloud of the proton. A.

537.533.74 : 539.152.1

374. Scattering of positrons and electrons by nuclei. H. J. Lipkin and M. G. White. Letter in *Phys. Rev.*, **79**, 892–3 (*Sept.* 1, 1950).

537.533.74 : 539.152.1

375. The effect of nuclear structure on the elastic scattering of fast electrons. L. R. B. Elton. *Proc. Phys. Soc., Lond. A*, **63**, 1115–24 (*Oct.*, 1950).

The cross-section for the scattering of electrons by atomic nuclei is investigated at energies for which the nuclei can no longer be treated as point charges. Two simple nuclear models are used. A general expression is obtained using Born's approximation, and an exact numerical calculation is carried through for 20 MeV electrons scattered by Au nuclei. It is concluded that at this energy considerable deviations from the formulae which treat the nucleus as a point charge should be expected, and that these should furnish some information about the charge distribution within the nucleus. A.

537.533.9

376. On the Cherenkov effect and the complex Doppler effect. A. I. Akhiezer, G. L. Lyubarskiĭ and Ya. B. Faĭnberg. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 1) 55–8 (1950) *In Russian.*

Mathematical. The emission of electromagnetic waves in the Cherenkov effect is examined in the case of linear periodic structures. A general formula for intensity and the discrete frequency spectrum follows. The case of a cylindrical waveguide is also investigated. J. JACOBS

537.533.9

377. The interaction of a beam of charged particles with electron plasma. A. I. Akhiezer and Ya. B. Faĭnberg. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 4) 555–6 (1949).

537.534

378. A modification of the radiofrequency mass spectrometer. A. F. Henson. Letter in *J. Appl. Phys.*, **21**, 1063–4 (*Oct.*, 1950).

537.534

379. A mass indicator. V. J. Caldecourt. Note in *Rev. Sci. Instrum.*, **21**, 772 (*Aug.*, 1950).

Output voltages of the magnetic field generator of a mass spectrometer and of a permanent magnet d.c. generator are compared by means of a self-balancing potentiometer of high input impedance, so that the effects of varying motor speed and commutator contact resistance are eliminated. Each generator is driven by a synchronous motor. Masses are indicated on a film-strip, and masses 200 and 201 are separated by 1 cm, with readings steady to 0·5 mm.

T. G. PICKAVANCE

537.534

380. Particle accelerators requiring magnetic fields. J. S. Gooden and J. H. Fremlin. *Rep. Phys. Soc. Progr. Phys.*, **13**, 295–349 (1950).

The more important accelerators, requiring the use of magnetic fields to control the particle orbits, are described and compared. These are (1) the fixed-frequency cyclotron, (2) the frequency-modulated cyclotron, (3) betatrons, (4) the electron synchrotron, (5) the proton synchrotron. The range of operation for which each machine is best suited is discussed. A large bibliography is appended. L. S. GODDARD

537.534 : 621.384.61 : 621.318.2 : 621.317.42

381. Field measurements on model betatron and synchrotron magnets. E. A. Finlay, J. F. Fowler and J. F. Smee. *J. Sci. Instrum.*, **27**, 264–70 (*Oct.*, 1950).

Measurements have been made of the magnetic field distribution in the air gap and of flux leakage for a "groove-coil" betatron magnet and for a synchrotron magnet. The synchrotron magnet was a complete solid of revolution, and was intended to simulate a magnet built up from 20 C-shaped segments. The betatron magnet yoke resembled the ordinary shell-type transformer. The boundaries of the regions within which stable orbits could be established have been calculated. It was found that the betatron magnet could be converted to a synchrotron magnet simply by removing the central core, without reshaping the pole faces. The magnets were made of solid Fe and excited by d.c. A.

537.534.72 : 539.155.2 : 621.389

Mass spectrometer improvements for abundance ratio measurements. *See Abstr.* 562

537.534.74

382. Results of 12·4-Mev proton-proton scattering at 90°. F. E. Faris and B. T. Wright. *Phys. Rev.* **79**, 577–82 (*Aug.* 15, 1950).

The differential cross-section in the centre-of-mass system for 12·4 MeV *p-p* scattering has been determined in the neighbourhood of a scattering angle of 90°. A photographic technique was used with a camera having cylindrical symmetry. The function $f(E)$ as defined by Bethe has been calculated for each of the 3 cross-section runs which were made. The average value of $f(E)$ as determined by the experiment agrees closely with the value predicted by a linear extrapolation from the results below 4 MeV. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 621.387 : 621.385.2

383. High frequency impedance of low pressure gaseous diodes. C. Yeh and E. L. Chaffee. *J. Appl. Phys.*, **21**, 981–6 (*Oct.*, 1950).

A simple theory of the lagging effect of the positive ions in neutralizing the space charge near the cathode of a gaseous diode is developed. By means of bridge measurement up to a frequency of 350 or 1 000 kc/s, depending upon the type of tube used, the theory is checked experimentally in terms of the h.f. impedance of the diodes. The transit time and the lifetime of a positive ion, its effectiveness in neutralizing space charge, etc., can be deduced from the theoretical and experimental investigations. A.

537.542

384. Boron trifluoride proportional counters. I. L. Fowler and P. R. Tunnicliffe. *Rev. Sci. Instrum.*, **21**, 734–40 (*Aug.*, 1950).

Counters of calculable efficiency for neutron beam measurements are described. It has been found possible to obtain excellent pulse-size distributions with a filling of 60 cm of purified BF_3 by "soaking" the counters for a long time (up to 3 months) with BF_3 before putting in the final filling. These fillings are stable. Fillings of less than 5 cm BF_3 made up to 50 cm with A have also been studied. With these fillings the pulse-size distributions are very good for both beam and total irradiation conditions. A discussion of the counter efficiencies with particular reference to end correction is given. A.

537.542

385. An anomalous effect observed in self-quenching counters containing neon. A. D. Krumbein. Letter in *Phys. Rev.*, **79**, 910 (*Sept.* 1, 1950).

537.542 : 621.387.42

386. The properties of proportional tubes and ion chambers with glass envelopes and external graphite electrodes. A. L. Cockroft and J. M. Valentine. *J. Sci. Instrum.*, **27**, 262–3 (*Oct.*, 1950).

Proportional tubes and ion chambers are described, the cathodes of which consist of graphite coatings on the external surfaces of the glass envelopes. Currents in the range 10^{-12} to 10^{-11} A pass through the walls of soft glass envelopes with negligible voltage drop. The potential of the inner surface of a hard glass chamber gradually changes due to the accumulation of surface charge. The change of potential is readily tolerated, however, in experiments of normal duration. A.

537.542

387. The form of the impulse in an ionisation chamber. A. I. Petrukhin, M. I. Podgoretskiĭ, N. D. Fedorov, L. N. Shtarkov and M. N. Shcherbakova. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 4) 539–41 (1949).

537.542

388. High pressure ionization chamber counters and their use. R. Wilson, L. Beghian, C. H. Collie, H. Halban and G. R. Bishop. *Rev. Sci. Instrum.*, **21**, 699–705 (*Aug.*, 1950).

Certain new developments in ionization chamber technique are described. Ionization chamber counters have been designed to operate with fillings of H_2, D_2 or CH_4 to pressures of 35 atmos. with simple filling techniques. The design, characteristics and uses of these counters are described. A.

537.542

389. Mobility of electrons and holes in diamond. E. A. Pearlstein and R. B. Sutton. Letter in *Phys. Rev.*, **79**, 907 (*Sept.* 1, 1950).

537.542 : 537.531

390. Natural crystal greenockite (cadmium sulfide) as an X-ray detector. E. L. Criscuolo and D. T. O'Connor. Letter in *J. Appl. Phys.*, **21**, 1196 (*Nov.*, 1950).

537.542

391. The measurement of proton energies with scintillation counters. W. Franzen, R. W. Peelle and R. Sherr. Letter in *Phys. Rev.*, **79**, 742–3 (*Aug.* 15, 1950).

537.542 : 621.318.572 : 621.387.42

392. A new counter tube arrangement with high resolving power. A. Trost. *Z. angew. Phys.*, **2** (*No.* 7) 286–9 (1950) *In German.*

A gas tube is used to integrate the pulse output from the G.M. tube and amplified. A deflection proportional to the number of counts is registered

on a d.c. meter. The apparatus can register up to 10^5 counts/sec. A discussion of the life of vapour-filled G.M. tubes is included. A. H. W. BECK (R)

537.542 : 621.318.572

393. Random coincidence rates with unsteady sources. R. M. LITTAUER. *Rev. Sci. Instrum.*, **21**, 750–2 (*Aug.*, 1950).

The random coincidence rate between two sets of pulses can be measured by delaying one of the sets through a time greater than twice the resolving time of the coincidence detector, thus destroying all true coincidences. A circuit using this principle for supervising the random rate continuously is described. A.

537.542

394. Effect of time lag in the measurement of delayed coincidences with G. M. counters. B. D. NAG, S. SEN AND S. CHATTERJI. *Indian J. Phys.*, **24**, 261–4 (*June*, 1950).

An expression for the delayed coincidences has been derived for both instantaneous and delayed radiations. The time lag between the ionizing event and its recording by the G. M. counters has been assumed to have a Gaussian distribution as a first approximation. The distribution function for the time lag has been found to differ from the Gaussian error function. Experimental curves can be checked against deduced inequalities. These checks have been used to check published curves for the delayed coincidence method of determining short-lived meta-stable states in isomeric nuclei. A.

537.542 : 621.318.572

395. A 99-channel pulse spectrograph. E. GATTI. *Nuovo. Cim.*, **7**, 655–73 (*July*, 1950) *In Italian.*

A 99-channel analyser of the Wilkinson type is described. Electronic instead of mechanical relays are systematically used. These and other modifications were introduced to improve counting velocity and flexibility. A.

537.542 : 621.396.615.17

396. A portable pulse generator for the analysis of coincidence circuits. M. CONVERSI. *Nuovo Cim.*, **7**, 674–6 (*July*, 1950) *In Italian.*

537.542

397. Control of a Wilson cloud chamber by means of an internal counter. A. L. HODSON AND A. LORIA. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 369–70 (1949).

Control of a cloud chamber by an internal counter of which the sensitive volume is not separated from the main chamber volume by any wall (and, in fact, forms part of the usable chamber volume) is described. The counter is operated in A and alcohol at 120 cm Hg pressure in the proportional region, and migration of positive ions is suppressed electronically. Application to the selection of heavily ionizing particles and to studies of counter mechanism are indicated.

J. G. WILSON

537.542

398. Two counter systems for the investigation of nuclear showers. J. DAUDIN. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 482–4 (1949) *In French.*

Describes: (1) An arrangement of counters and Pb absorbers for cloud chamber control in which the 3 counters are relatively heavily shielded from each other, but the chamber will receive particles of local showers after little absorption. (2) A counter array requiring at least 4 particles for operation which is used to investigate the Rossi transition at 2 860 m in thin absorbers and in conjunction with a large counter tray at 3 m which indicates events associated with air showers. Events not associated with air showers increase rapidly with absorber thickness and are identified with nuclear explosions. J. G. WILSON

537.543 : 621.385.2

399. Theory of the parallel plane diode. A. H. TAUB AND N. WAX. *J. Appl. Phys.*, **21**, 974–80 (*Oct.*, 1950).

Transient and steady state solutions are obtained. The limitations on a single valued velocity theory are investigated. These general results are applied to the space-charge-limited diode with the a.c. components small compared to the d.c. Power consumption is discussed and it is shown that hitherto neglected terms are of importance. A.

537.543 : 621.385.832

400. Storage of small signals on a dielectric surface. J. V. HARRINGTON. *J. Appl. Phys.*, **21**, 1048–53 (*Oct.*, 1950).

A mathematical analysis is presented which may be applicable to a general class of storage tubes where signal storage is accomplished by depositing through secondary emission a charge pattern on a dielectric surface. The assumptions made to linearize and simplify the problem are outlined and plots are given of the predicted output signals for writing, reading, and cancellation operations when the input signal is a step function. Experimental evidence given substantiates the analytical results. A.

IONIZATION . THERMIONICS 537.56/.58

537.56

401. The ionization of hydrogen in metals. I. ISENBERG. Letter in *Phys. Rev.*, **79**, 736–7 (*Aug.* 15, 1950).

537.562

402. Microwave determinations of average electron energies and the first Townsend coefficient in hydrogen. L. J. VARNERIN, JR. AND S. C. BROWN. *Phys. Rev.*, **79**, 946–51 (*Sept.* 15, 1950).

A microwave method of measuring the average energy of electrons in a gas in the presence of a d.c. field has been developed through a measurement of the ratio between the electron diffusion and mobility. By solving for a.c. and d.c. distribution functions it is found possible to compare quantitatively the effective a.c. ionization coefficient and the first Townsend coefficient in H. It is then possible to calculate the first Townsend coefficient from a.c. breakdown data in H and these values are compared with previously determined values. Measurements of average energy have been made and values calculated from theory compared with previous measurements of average energy. All measurements are in substantial agreement with each other and with the theoretically determined values. A.

537.564

403. Ionization of the negative oxygen ion by electron impact. III. M. WATANABE AND J. MIDA. *J. Phys. Soc., Japan*, **5**, 149–54 (*May-June*, 1950).

For Pts I and II see Abstr. 5903–4 (1950). III gives the calculations of the cross-section for electron detachment by electron collision, which is found to be large for colliding energies exceeding the electron affinity. F. LLEWELLYN JONES

537.567

404. Ionization measurements at very high intensities. I. Pulsed radiation beams. J. W. BOAG. *J. Brit. Radiol.*, **23**, 601–11 (*Oct.*, 1950).

In pulsed radiation beams the high ion density produced by each pulse encourages recombination between ions of opposite signs. Formulae are derived for the proportion of ions escaping recombination in plane parallel, cylindrical and spherical ionization chambers under a variety of different conditions. The screening effect of space charge is shown to be small in the case of plane geometry. The effect of an exponential fall in collecting voltage, as in condenser chambers, is considered and the appropriate collecting efficiency is derived. Some experimental measurements on a 4 MeV linear accelerator are described. A.

537.58 : 621.385.1.032.216

405. Effect of coating composition of oxide-coated cathodes on electron emission. E. G. WIDELL AND R. A. HELLAR. *J. Appl. Phys.*, **21**, 1115–18 (*Nov.*, 1950).

Oxide-coated cathodes have been investigated to determine the effect on electron emission of varying the proportions of emitting oxides. The results show that maximum electron emission under saturation conditions is obtained from a solid solution containing SrO and BaO in an approximate molecular ratio of 7 to 3. These results also indicate that maximum size of the co-precipitated alkaline-earth carbonate particle occurs at the same molecular ratio as that giving maximum electron emission from the oxides. When the saturation emission obtained with a square-wave voltage pulse was measured, the current pulse as observed on a synchroscope was also a square wave and showed no measurable decay characteristic for a pulse duration time of 10 μsec. A.

537.58 : 621.385.1.032.44

406. End-cooling of power tube filaments. J. W. CLARK AND R. E. NEUBERT. *J. Appl. Phys.*, **21**, 1084–7 (*Nov.*, 1950).

537.583

407. The barium oxide on tungsten cathode interface. E. B. HENSLEY AND J. H. AFFLECK. Letter in *J. Appl. Phys.*, **21**, 938–9 (*Sept.*, 1950).

Reports results of X-ray diffraction examinations of the interface product. This was found to be the tungstite, $BaWO_3$. This is stable in air, but oxidizes to the tungstate in water. The interfaces were prepared in a very good vacuum. Attempts made to prepare the tungstite in bulk in a vacuum furnace (10^{-5} mm Hg) failed, but mixing W powder with the carbonate spray and processing in a vacuum of 10^{-7} mm Hg yielded the tungstite. The cathodes reported on had no emission drawn from them but were heated for up to 1 000 hours. The interface thickness was measured as a function of time and was found to be constant at about 10^{-4} cm.

A. H. W. BECK

537.585

408. The life of a heated tungsten spiral and the evaporation rate of tungsten in high vacuum. E. BAS-TAYMAZ. *Z. angew. Phys.*, **2** (*No.* 9) 374–6 (1950) *In German.*

W spirals were burned in vacuum at various temperatures until they failed by evaporation. The life in hours was given by $\log t = -15 + 46\,500\,T^{-1}$ and the diameter had decreased by 15% at failure. The rate of evaporation was calculated from the same data and agreed well with the results of Zwikker (Diss. Amsterdam 1925). Traces of pump oil had no effect and it is believed that short filament lives in electron microscopes, etc., are due to ion bombardment rather than to relatively poor vacua.

A. H. W. BECK

COSMIC RAYS 537.591

537.591.1

409. On the positive excess of the hard component in cosmic-ray. S. OGAWA. Letter in *Progr. Theor. Phys.*, **5**, 490–1 (*May–June*, 1950).

Summarizes experimental results obtained at various atmospheric depths. E. P. GEORGE

537.591.1

410. The determination of the multiplicity of the spectrum of the meson produced by the nucleon–nucleon collision. S. OGAWA. Letter in *Progr. Theor. Phys.*, **5**, 489–90 (*May–June*, 1950).

A value for the positive excess is calculated, disagreeing with the experimental results collected in the preceding abstract. E. P. GEORGE

537.591.1

411. Note on the heavy nuclei of the cosmic radiation. A. D. DAINTON AND D. W. KENT. Letter in *Phil. Mag.*, **41**, 963–6 (*Sept.*, 1950).

Heavy nuclei are studied in photographic emulsions exposed for 100 min at 68 000′. From the angular distribution a range ~ 28 g cm^{-2} is deduced, and an incident intensity $1{\cdot}3 \times 10^{-3}$ cm^{-2} sec^{-1} sterad^{-1}. It is pointed out, however, that heavy primaries frequently undergo fragmentation in collision, and it is possible that some of the particles observed at 68 000 ft are secondary fragments of this kind.

J. G. WILSON

537.591.1

412. The momentum and sign of fast cosmic ray particles. J. E. MOYAL. *Phil. Mag.*, **41**, 1058–77 (*Oct.*, 1950).

The probability distribution of the observed angular deviations along the track is derived, taking into account errors of observations. Approximate expressions are obtained for the maximum likelihood estimates of the magnetic deviation and the mean-square scattering deviation. The standard errors of these estimates are found, and their efficiency is discussed. After showing how the observations of

magnetic and scattering deviations in a large number of tracks can be combined to verify theoretical mean-square scattering formulae, the estimation of the momentum p of particles from these deviations is discussed. An expression is given for the probability that, given the signed total deviation of a track in the magnetic field, the particle should be positively or negatively charged. A method is given of estimating the ratio of positively to negatively charged particles in terms of the observed signed deviations in a number of tracks. A.

537.591.1

413. Relation between π- and μ-meson production spectra in the atmosphere. G. Ascoli. *Phys. Rev.*, **79**, 812–14 (*Sept.* 1, 1950).

A method of obtaining the parent π-meson spectrum from the μ-meson spectrum is presented and the relation of the two spectra is discussed. It is concluded that the μ-meson spectrum must be rather smooth even if the parent spectrum is not. A.

537.591.1

414. On the origin of the cosmic radiation. C. Y. Fan. Letter in *Phys. Rev.*, **79**, 912–13 (*Sept.* 1, 1950).

Fermi's theory of the origin is developed. The calculated energy-spectrum of the primary particles is compared with experimental results. Discrepancies at low energies are due to uncertainties in the numerical values to be inserted in the formulae.

E. P. GEORGE

537.591.1

415. The intensity and masses of cosmic-ray particles. T. C. Merkle, Jr., E. L. Goldwasser and R. B. Brode. *Phys. Rev.*, **79**, 926–8 (*Sept.* 15, 1950).

Measurements have been made of the relative numbers of mesons and protons in the sea-level cosmic radiation. The measurements include those particles that have ranges in Pb between 4·0 and 13·0 cm. The masses were determined by observing the range and momentum of each particle. No evidence was found for any particles except positive protons (mass $= 1893 \pm 50\, m_e$) and positive and negative μ-mesons (mass $= 196 \pm 3\, m_e$). The low value of the μ-meson mass reported here may be due in part to the uncertainty of the range-energy relations in copper. As many protons as μ-mesons were observed in the range interval from 4·0 to 13·0 cm Pb. The intensity of protons decreased with increasing range. A.

537.591.1 : 523.165

416. An hypothesis on the origin of the cosmic radiation. E. Fermi. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 317–23 (1949).

If cosmic rays are assumed to be a galactic phenomenon nuclear collisions with diffuse matter set an average age $\sim 10^8$ years for surviving cosmic ray nucleons. If, further, the formation of particles does not change with time, the age distribution will be exponential. Identifying the observed energy distribution with the age distribution, a rate of increment of energy is required which would arise in collisions once per light year with large bodies of random velocity of the order 30 km/sec. These bodies are identified with the entrained magnetic fields of interstellar clouds. The hypothesis requires particles which will subsequently be accelerated to reach a threshold (injection) energy by other means. This threshold is ~ 100 MeV for protons, but ~ 5 BeV per nucleon for heavy nuclei, and the very high values indicated for heavy nuclei represent a limitation of the picture. J. G. WILSON

537.591.1 : 523.165 : 523.75

417. Solar flares and the origin of cosmic radiation. J. Clay, A. J. Dijker and H. F. Jongen. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 332–45 (1949).

Variations of cosmic-ray intensity at times of solar activity have been correlated with the detailed history of flares and spots. The cosmic-ray data refer mainly to ionization chamber measurements with 4 units under from 0 to 110 cm Fe shielding and filled to between 40–100 atmos. A, at Amsterdam.

J. G. WILSON

537.591.15

418. The radiation complex of extensive air showers. J. Clay. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 353–62 (1949).

Experiments are described in which the nature of coherence of soft and penetrating particles in extensive showers, and the effect of the equilibrium photon flux in the shower on transition data, are studied. It is shown that the barometer effect for the penetrating component is the same as for the main soft showers. J. G. WILSON

537.591.15

419. Interpretation of nuclear showers and electronic component in cloud chamber photographs. J. Daudin. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 365–8 (1949) *In French.*

Re-examination of cloud chamber photographs (without magnetic field) of 1943 leads to the conclusions: (*a*) that there is no essential difference between penetrating showers associated and not associated with air showers; (*b*) that the electrons or photons secondary to nuclear encounters are produced multiply; (*c*) that there is probably an intermediate particle of short range; (*d*) that there is not evidence of a light (λ) meson. A remarkable electronic shower is noted issuing at 10° to the horizontal from a large thickness of rock. J. G. WILSON

537.591.15

420. On the distribution of penetrating particles in extensive cosmic ray showers. C. Milone, S. Tamburino and C. Villari. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 373 (1949) *In Italian.*

The percentage of particles penetrating 15 cm in extensive showers of electron density $35 < \Delta < 105\ \mathrm{m}^{-2}$ has been determined, and the variation of density of the penetrating particles and of the electrons up to 50 m from the shower core measured.

J. G. WILSON

537.591.15

421. Computation of operation of coincidence counters by extensive showers. G. Molière. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 374–6 (1949) *In German.*

The effect on the decoherence curve for two counters of the depth in the atmosphere of the initiation of an extensive shower is determined, and is compared with the experiments of Auger. The observations fit the computed curve for a depth of formation of the order 6 cascade units.

J. G. WILSON

537.591.15

422. Cloud chamber studies of penetrating showers. P. M. S. BLACKETT. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 459–61 (1949).

See Abstr. 3820 (1948), 1088, 3305 (1949) and 3236 (1950).

537.591.15

423. On the production and multiplicity of penetrating showers. L. MEZZETTI AND R. QUERZOLI. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 488–90 (1949).

An array of counters at 3 500 m requires for operation a single particle to (*a*) traverse two 1 cm Pb plates without secondaries, (*b*) lead to at least two particles emerging from a variable production layer, and (*c*) lead to at least two particles below a further 7·5 cm Pb. An estimate of multiplicity below the production layer is given by the number out of seven counter sub-groups discharged. Production layers, 17 g cm^{-2} C and 46 g cm^{-2} Pb (equivalent geometrical cross-sections) lead to roughly similar rates, with indications of greater frequency of high multiplicity under Pb which may be associated with different development of the secondary electronic component. J. G. WILSON

537.591.15

424. On the nuclear interaction of the secondary particles of the hard showers. O. PICCIONI. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 521–2 (1949).

See Abstr. 3233, 3234 (1950).

537.591.15

425. The nature of the penetrating particles in air showers. L. JANOSSY AND C. B. A. MCCUSKER. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 535–7 (1949).

An experiment in which the 3 shielded trays of a Janossy type shower set covered with 20 cm Pb are all divided into 2 sub-groups, is carried out with 2 unshielded trays (*a*) forming a telescope above the penetrating shower set, (*b*) spread to detect air showers. The number of discharges of both sub-groups in 1, 2 or 3 trays in the 2 conditions leads to the conclusion that at least 30% of the penetrating events in air showers do not arise from the penetration of the set by pre-existing μ-mesons. J. G. WILSON

537.591.15

426. On the penetrating showers. G. WATAGHIN. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 538–41 (1949).

(1) Experiments are described with a penetrating shower detecting counter array which is considered to be mainly sensitive to showers originating in air rather than in the local Pb absorber, and to detect these almost isotropically. No significant difference of shower intensity or of the absorption coefficient in the lower atmosphere was detected between the geomagnetic equator and latitude 47°N geomag. (2) A similar detecting array was used to compare the intensity of shower formation in layers of C and paraffin (of equal C content) placed 50 cm above the detector. J. G. WILSON

537.591.15

427. An investigation of the structure of showers produced by primary cosmic rays in the stratosphere. S. N. VERNOV AND A. N. CHARAKHCHYAN. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 4) 523–5 (1949).

537.591.15

428. Report on recent work on penetrating showers and penetrating particles. II. K. SITTE. *Acta Phys. Austriaca*, **4** (*No.* 1) 18–61 (1950) *In German.*

For Part I, see Abstr. 3226 (1950). In this part, developments in 1947–48 are summarized. The Broadbent–Janossy separation of local and extensive penetrating showers and their analysis of the nature of extensive penetrating events are examined, and the development and implications of the "λ-meson" (light meson) hypothesis are treated in detail. Material up to Sept. 1949 has been briefly summarized at proof stage. J. G. WILSON

537.591.15

429. The density transition effect in electro-nuclear showers. M. I. PODGORETSKIĬ, A. I. BARCHUKOV AND D. F. RAKITIN. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 4) 685–8 (1950) *In Russian.*

The transition effect is taken as evidence for nucleon-cascades. E. P. GEORGE

537.591.15

430. On the spread of photons in a shower. A. BORSELLINO. *Nuovo Cim.*, **7**, 638–54 (*July*, 1950) *In Italian.*

The paper values the angular and lateral spread of the photons in a big shower. The r.m.s. of spread is defined by means of the distributions of electrons and photons, which are solutions of Landau's equations. Using the Melling–Laplace–Fourier transformation, the problem is reduced to a linear equation of finite difference type and to an ordinary equation if the ionization is neglected. In this case, the inversion of the transformations yields (for $n = 0, 1, 2$) an expression which indicates a sensitive dependence on the depth. The spread averaged on the depth may be calculated and is equal to the spread at the shower's maximum ($s = 1$). Also the average spread of particles (electrons or photons) with energy greater than E is calculated and is the same relation as at the maximum. With a distributed source of the soft component (neutretto), the coincidence of the averaged spread on the depth with the spread at the maximum may explain the accordance of the experimental results of Cocconi and agree with Molière's distribution (evaluated at the maximum). A.

537.591.15

431. On the angular and lateral distribution functions of extensive showers. A. BORSELLINO. *Nuovo Cim.*, **7**, 700–2 (*July*, 1950) *In Italian.*

Theoretical. Formulae for the distribution functions at all depths in a shower are given. E. P. GEORGE

537.591.15

432. The shape of the Rossi curve. W. BOTHE AND H. THURN. Letter in *Phys. Rev.*, **79**, 544–5 (*Aug.* 1, 1950).

Data about the second Rossi maximum, confirming in particular the existence of showers of two particles only, produced by μ-mesons and of small angular separation ($\sim 10°$), are described. The production cross-section is estimated at a few percent of the geometric cross-section in Pb. J. G. WILSON

537.591.15

433. Intensity and lateral distribution of the *N*-component in the extensive showers of the cosmic radiation. G. Cocconi and V. Cocconi Tongiorgi. Letter in *Phys. Rev.*, **79**, 730–2 (*Aug.* 15, 1950).

537.591.15

434. On the particles initiating high energy penetrating showers. M. B. Gottlieb, A. J. Hartzler and M. Schein. Letter in *Phys. Rev.*, **79**, 741–2 (*Aug.* 15, 1950).

537.591.15

435. Fluctuations of the electron-photon cascade—moments of the distribution. L. Janossy and H. Messel. *Proc. Phys. Soc., Lond. A*, **63**, 1101–15 (*Oct.*, 1950).

The second moments of the electron-photon cascades are evaluated. It is found that the mean square fluctuation at the cascade maximum is that expected for a Poisson distribution or less; before and after the maximum the fluctuation exceeds greatly that expected for a Poisson distribution. The correlation coefficient between electrons and photons is zero for small thicknesses or near the cascade maximum. For other regions the correlation coefficient is positive. Both mean square fluctuation and correlation between electrons and photons can be understood qualitatively in terms of fluctuation of effective depth. A.

537.591.15 : 537.591.3

436. Narrow air showers of cosmic rays. II. Absorption measurements. J. P. N. Wei. *Phys. Rev.*, **79**, 670–4 (*Aug.* 15, 1950).

The absorption of narrow air showers in Pb, Fe and Al has been measured at sea level. Results indicate that there are two components in these narrow air showers, a soft component which consists of electrons and a hard component which consists of μ-mesons. The soft component is practically completely absorbed in 4 in Pb, whereas the hard component is not appreciably absorbed in $8\frac{1}{2}$ in Pb. A wooden roof of only 1 g cm^{-2} produces many local showers, which are nevertheless totally absorbed in a very thin layer of material. A.

537.591.15 : 537.591.5

437. The altitude variation of the penetrating component of broad atmospheric showers of cosmic rays. G. T. Zatsepin, I. L. Rozental and S. A. Slavatinskiĭ. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 4) 531–3 (1949).

537.591.15 : 537.591.5

438. Measurement of the altitude variation of electron-nuclear showers. L. Kurnosova and N. Tikhonova. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 4) 535–7 (1949).

537.591.2

439. A magnetic cosmic-ray spectrograph with counter recording. B. D. Hyams, M. G. Mylroi, B. G. Owen and J. G. Wilson. *Proc. Phys. Soc., Lond. A*, **63**, 1053–74 (*Oct.*, 1950).

An instrument is described in which the momentum of single cosmic-ray particles is measured, the particles leaving the instrument in a sufficiently collimated beam for use in subsequent experiments. The "maximum detectable momentum" of the apparatus is about 3×10^{10} eV/C, almost all particles are collected within 10° of the zenith and in directions individually defined to ± 1°, the output is about 400 particles/day, and the proportion of spurious records is of the order of, or less than, 0·1%. A.

537.591.2

440. A magnetic cosmic-ray spectrograph with counter recording. II. The electronic and recording system. B. G. Owen. *Proc. Phys. Soc., Lond. A*, **63**, 1074–80 (*Oct.*, 1950).

The paper describes the electronic selection and recording systems of the spectrograph and the performance and overall serviceability of the equipment as shown in continuous operation over about one year. A.

537.591.3

441. The energy distribution of cosmic ray disintegration stars, and the absorption in air of the star-producing radiation. C. Peyrou. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 408–10 (1949) *In French.*

The frequency of stars, as a function of star size, is compared at atmospheric depths 665 g cm^{-2} (Jungfraujoch) and 58 g cm^{-2} (balloon). In both exposures a discontinuity at about 9 prongs is attributed to the contribution of stars from the light elements of the emulsion to small stars. The size variation of large stars is much less rapid in the 58 g cm^{-2} exposure than at Jungfraujoch, and the apparent absorption coefficient of the star-producing radiation accordingly increases with star size. J. G. Wilson.

537.591.5

442. The E–W asymmetry of isolated tracks produced by cosmic rays in nuclear emulsions. M. Morand. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 403–7 (1949) *In French.*

The asymmetry shown by isolated particles and the nature of these particles at altitudes 1 600 m and 4 500 m at the geomagnetic equator and at 2 300 m in 22° N geomagnetic latitude is discussed, the most significant results being based on particles which reach the end of their range in the emulsion. The asymmetry is most pronounced at the lower altitudes. J. G. Wilson.

537.591.5

443. Excess of positive mesons at 9·15 km above sea level. M. Conversi. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 476–8 (1949).

The charge ratio of slow mesons (up to 180 g cm^{-2}) at sea level and at 9 145 m altitude is derived from the relative counting rates in 4 spaced delayed channels after absorption in C and S respectively. Although statistical uncertainty is large, an increase of positive-negative ratio with altitude, which may be due to the behaviour of absorbed π-mesons is probable. J. G. Wilson.

537.591.5

444. Altitude dependence and latitude dependence at 9 145 m of penetrating particles slowed down after traversing 15 cm of lead. M. Conversi. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 479–81 (1949).

Observations were made at 9 145 m over a range of geomagnetic latitudes of particles stopping in 10 cm C after penetrating 15 cm Pb, (*a*) which produce μ-*e* delayed coincidences, (*b*) for which no μ-*e* decay

particle is detected. In control experiments at sea level the whole of (*b*) is attributed to μ-*e* decays for which the product escapes detection, the efficiency of detection at all altitudes being then deduced. At 9 145 m additional counts in (*b*) are attributed to different particles. These show the strong geomagnetic latitude effect appropriate to nucleons.

J. G. WILSON

537.591.5

445. The empirical zenith-angle distribution of the hard component in the lower atmosphere. A. FRÉON AND TSAÏ-CHU. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 529–30 (1949) *In French.*

Measurements of the zenith-angle variation at 73 m altitude in latitude 49° N geomag. and at 2 058 m in latitude 43° N geomag. are discussed. J. G. WILSON

537.591.5

446. Cosmic ray measurements between Australia and Japan. P. G. LAW, C. D. MCKENZIE AND H. D. RATHGEBER. *Aust. J. Sci. Res. A*, **2**, 493–505 (*Dec.*, 1949).

A latitude effect of 20% was found for rays of vertical incidence. The difference between electron and meson components did not exceed the statistical errors of 2%. For wide angle coincidence telescope measurements the latitude effect reduces to 13%. Further it has been found that a latitude effect of some 10% exists for extensive showers of an average spread of 1 m. An observed latitude effect of penetrating extensive showers falls, however, within the standard deviation of the measurements. Evidence is presented of the existence of a semi-diurnal variation at the equator and at Kure of opposite phase to the barometric pressure variations and of about twice the coefficient of the normal barometric effect. A.

537.591.5

447. Angular distribution of cosmic rays in the stratosphere. S. N. VERNOV AND A. M. KULIKOV. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 3) 483–6 (1950) *In Russian.*

A 3-fold counter telescope was flown at various heights up to 30 km. The inclination to the vertical was varied in a cyclic manner between 0 and 90°. Results are given for both 4 cm Al and 8 cm Pb absorbers in the telescope. Coincidences with a displaced counter were used to correct for showers.

E. P. GEORGE

537.591.5

448. On the east-west effect of the cosmic-radiation in the upper atmosphere. S. OGAWA AND Y. NAGAHARA. *Progr. Theor. Phys.*, **5**, 428–36 (*May–June*, 1950).

The fact that in the upper atmosphere there is a symmetry of the east-west intensity of the cosmic ray, introduces a difficulty in the proton primary hypothesis which is assumed from the experimental results of the east-west asymmetry on each latitude and at each altitude from sea-level to 10 000 m. To remedy the situation Arley assumed that there exist negative protons in the primaries. But the mechanism, by which negative proton directly gives the soft component, is not clear. To make clear to what extent the problem of east-west effect can be solved from the standpoint which is now accepted—that is, primary proton gives π-meson and π-meson decays into μ-meson which gives the soft component by disintegration—the angular distribution between the primary proton and the produced soft component has been investigated. A.

537.591.5

449. Effect of latitude on the nucleonic component of cosmic radiation. P. CALDIROLA AND G. ZIN. *Nuovo Cim.*, **7**, 575–88 (*July*, 1950) *In Italian.*

The effect of the latitude cut-off on the distribution law of the nucleonic (protonic, neutronic and total) component in cosmic radiation throughout the whole atmosphere is calculated and discussed starting from the assumption of the existence at the limit of the atmosphere of a primary radiation consisting of protons having an integral energy spectrum proportional to E^{-s} and assuming a model for the "plural" creation of mesons suggested in a preceding paper [Abstr. 3250 (1950)]. The theoretical results are finally compared with those of other authors and with experimental data. A.

537.591.5

450. Cosmic radiation at large depths. C. M. GARELLI AND G. WATAGHIN. *Nuovo Cim.*, **7**, 695–6 (*July*, 1950) *In Italian.*

The energy loss of fast μ-mesons is calculated, including the effects of ionization, decay, bremsstrahlung, electron pair production and π-meson production by electromagnetic interaction. The depth-intensity curve is then evaluated assuming for energetic π-mesons (*a*) a weak, and (*b*) a strong nuclear interaction. The experimental results appear to fit assumption (*a*) better. E. P. GEORGE

537.591.5

451. A directional and latitude survey of cosmic rays at high altitudes. J. R. WINCKLER, T. STIX, K. DWIGHT AND R. SABIN. *Phys. Rev.*, **79**, 656–69 (*Aug.* 15, 1950).

The directional distribution of cosmic rays at atmospheric depths of 15 to 25 g/cm^2 has been measured with large counter telescopes carried by constant-level plastic balloons at geomagnetic latitudes of 0°, 20°, 30° and 40°. From the vertical flux measurements an energy spectrum for primary protons is obtained which has the form $N(E) = 0{\cdot}27/E^{1{\cdot}9}$, where $N(E)$ is the number of particles in unit energy range at the energy E. The corresponding formula for primaries consisting entirely of alpha-particles is $N(E) = 0{\cdot}32/E^{1{\cdot}81}$. The power law can be fitted between about 1 and 14 BeV, but there is good evidence that the spectrum flattens out below 1 BeV and becomes steeper at high energies. The total incident energy calculated under the assumption that the measured flux at 15 g/cm^2 consists of primaries is two times greater than the total incident energy appearing as atmospheric ionization. The east-west asymmetry values reach a maximum of $0{\cdot}53 \pm 0{\cdot}05$ at the equator and decrease to $0{\cdot}24 \pm 0{\cdot}09$ at 40° geomagnetic latitude. The asymmetry to be expected from the latitude effect if all primaries are positive, reaches 1·20 at the equator, and at all latitudes and zenith angles is considerably higher than the observed asymmetry. It is not possible to decide on the basis of the present experiments whether this discrepancy

arises from atmospheric effects or from a sizable fraction of negative primaries. A.

537.591.5

452. Cosmic-ray underground. S. HAYAKAWA, K. MANO AND T. MIYAZIMA. Letter in *Progr. Theor. Phys.*, **5**, 495–6 (*May–June*, 1950).

Assuming the rays penetrating below ground are μ-mesons, the expected angular distributions at depths up to 3 000 m are given graphically. The maximum theoretical temperature coefficient at 1 000 m depth is $+ 0{\cdot}4\%$ per °C. Concludes that the underground particles are μ-mesons. E. P. GEORGE

537.591.5

453. Cosmic rays underground. C. M. GARELLI AND G. WATAGHIN. Letter in *Phys. Rev.*, **79**, 718–19 (*Aug.* 15, 1950).

537.591.5

454. The absorption of penetrating cosmic rays underground. C. A. RANDALL, N. SHERMAN AND W. E. HAZEN. Letter in *Phys. Rev.*, **79**, 905 (*Sept.* 1, 1950).

537.591.5

455. Latitude effect of cosmic ray stars. S. LATTIMORE. Letter in *Phil. Mag.*, **41**, 961–3 (*Sept.*, 1950).

The rate of star production in Ilford G5 plates is compared at Jungfraujoch and in 12°s geomagnetic latitude in the Andes: the ratio is shown to be a function of star size, tending to unity for large stars. The total star rate is 2·1 times as great at Jungfraujoch as in the Andes and it is shown that about $\frac{1}{2}$ of the stars at Jungfraujoch must therefore arise from the latitude-sensitive difference of the primary spectra, i.e., approximately from primaries less than 15 BeV. J. G. WILSON

537.591.5

456. Experiments on cosmic-ray mesons and protons at several altitudes and latitudes. M. CONVERSI. *Phys. Rev.*, **79**, 749–67 (*Sept.* 1, 1950).

Experiments to obtain further information about the meson component and the nucleonic component present in the atmosphere have been carried out near sea level, and in a B-29 aircraft flying at different altitudes and latitudes, using G. M. counters simultaneously in delayed coincidence and in anti-coincidence. A.

537.591.5

457. Ionization chamber bursts at very high altitudes. G. W. MCCLURE AND M. A. POMERANTZ. Letter in *Phys. Rev.*, **79**, 911–12 (*Sept.* 1, 1950).

537.591.5

458. Observations on cosmic-ray penetrating showers at high altitude, sea level and below ground. E. P. GEORGE AND A. C. JASON. *Proc. Phys. Soc., Lond. A*, **63**, 1081–97 (*Oct.*, 1950).

Penetrating showers have been investigated, using Geiger counters, at a depth of 30 m below ground, at sea level and at an altitude of 3 457 m. The influence of the geometry of the absorbers was studied. The transition curves for local showers, corrected for this geometric effect, give the following collision lengths of the generating particles: Pb, 180 ± 40; Al, 85 ± 15; paraffin ~ 80 gm/cm^2. These values correspond to a collision cross-section close to the geometric cross-section of the nuclei. From the results obtained for extensive penetrating showers, it is concluded that most of the penetrating particles in these showers appear to be generated in the atmosphere. In 40 days, no penetrating showers were recorded below ground. Using photographic plates, the density distribution of shower tracks associated with nuclear disintegrations was found to be similar at sea level and 3 457 m. A.

537.591.5 : 523.752

459. A large fluctuation in the rate of production of nuclear disintegrations following a solar flare. J. J. LORD, A. W. ELSTON AND M. SCHEIN. Letter in *Phys. Rev.*, **79**, 540–1 (*Aug.* 1, 1950).

Nuclear emulsions were flown at 95 000 ft for 3·7 hr on May 11, 1949. During this period, a solar flare occurred. The frequency of stars with from 3 to 8 prongs was found to be 50% above normal. No change was observed in the intensity of heavy nuclei with atomic number greater than 10. E. P. GEORGE

537.591.5 : 523.752

460. The solar flare of November 19, 1949, and cosmic rays. J. CLAY AND H. F. JONGEN. Letter in *Phys. Rev.*, **79**, 908–9 (*Sept.* 1, 1950).

537.591.5 : 539.18

461. On the spectrum of mesons in function of the atmospheric depth. C. M. GARELLI. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 518–20 (1949).

The sea-level spectrum of μ-mesons and that at $\frac{1}{2}$ the atmospheric depth are computed for a constant index ($-2{\cdot}5$) of the primary spectrum, for an absorption law which is independent of energy and for a multiplicity of meson formation of the type proposed by Wataghin. J. G. WILSON

537.591.8

462. On the spectrum of light particles produced in cosmic ray disintegration. C. FRANZINETTI AND S. ROSENBLUM. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 349–50 (1949).

Measurements of momentum and residual range in photographic emulsions, by the sandwich method in a field of 29 000 gauss at Jungfraujoch, on 254 tracks indicate (*a*) 12% are in mass range 170–240 m_0, nearly all positives and 10% of negatives show electron decay; (*b*) 9% are in mass range 250–350 m_0, all positives show π–μ decay, 60% negatives produce disintegration; (*c*) 45% are in mass range 1 400–2 300 m_0, all positively charged and non-interacting; (*d*) 17% are positive, mass between 3 000 and 4 500 m_0, probably deuterons; (*e*) 15% mass $\sim 5\,000\ m_0$, probably α-particles; (*f*) 2·5% in region between π-mesons and protons, but not definite evidence of particles of intermediate mass. J. G. WILSON

537.591.8

463. The transition effect of star phenomena in cosmic rays. E. AMALDI, C. CASTAGNOLI, A. GIGLI AND S. SCIUTI. *Nuovo Cim.*, **7**, 697–9 (*July*, 1950) *In Italian.*

Bursts occurring in one only of 4 close-packed ion chambers were defined as stars. Those liberating 6·9 or 7·9 MeV in the chambers, operated at 3 400 m altitude, showed a small transition maximum at 2·5 cm Pb. No effect was noted for larger stars. E. P. GEORGE

537.591.8

464. Cascades of nuclear disintegrations induced by the cosmic radiation. G. Cocconi, V. Cocconi Tongiorgi and M. Widgoff. *Phys. Rev.*, **79**, 768–80 (*Sept.* 1, 1950).

Disintegrations induced by the *N*-component have been studied by detection of the moderate energy neutrons released in the disintegrations themselves. The pulses of the neutron counters appeared on the sweep of a cathode-ray tube. A hodoscope of Ne bulbs connected to an arrangement of G. M. counters was simultaneously used to study the relative number of neutral and charged primaries and the penetration of the ionizing particles produced in the disintegrations. Lifetime, angular distribution, and average energy of the neutrons have been investigated. The multiplicities of the neutrons produced in absorbers of different thickness and material have been determined. Evidence has been derived of the existence of conspicuous cascades of nuclear disintegrations. A tentative analysis of the nuclear cascade process is given. A.

537.591.8

465. Emission of neutral radiation in cosmic-ray stars. E. Pickup and L. Voyvodic. Letter in *Phys. Rev.*, **79**, 899–900 (*Sept.* 1, 1950).

537.591.8

466. Wide angle sprays produced by cosmic radiation. R. R. Rau and G. G. Harris. *Phys. Rev.*, **79**, 915–17 (*Sept.* 15, 1950).

New data are presented on the wide angle sprays which have been reported by Oppenheimer and Ney. A.

537.591.8

467. The magnetic deflection of fast charged particles in the photographic emulsion. C. C. Dilworth, S. J. Goldsack, Y. Goldschmidt-Clermont and F. Levy. *Phil. Mag.*, **41**, 1032–57 (*Oct.*, 1950).

Electron sensitive nuclear research emulsions have been exposed at sea level, and at the Pic du Midi (2 800 m) in magnetic fields of the order of 34 000 gauss, in order to test the possibilities of curvature, within the emulsion itself, of the tracks of charged cosmic ray particles. The existence of measurable deflections of long tracks has been established by comparison of the results of measurements on field and no field plates, and the method has been applied to determine the sign of particles in a group of cosmic ray phenomena in the exposures at high altitude. A.

537.591.8

468. Background tracks in electron-sensitive nuclear emulsions. J. H. Fremlin and M. C. Walters. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1178–9 (*Oct.*, 1950).

Ilford G5 200 μ plates exposed for 6 days at 600 m depth in a mine showed an increase of β tracks, over controls developed when the experimental plates were taken down the mine, of about 0·1 of that shown by sea level plates, although shielded by 2 in Pb. It is shown that local contamination (actually in emulsion or glass of plates) can only account for about 10% of the observed background at this depth, and that a considerable improvement is to be expected if plates can be exposed surrounded by "clean" screening material. J. G. WILSON

537.591.8 : 539.172

Nuclear events of very high energy in cosmic rays. *See Abstr.* 599

537.591.8 : 539.172

Nuclear evaporation and other phenomena produced by high energy neutrons, α-particles, deuterons, π-mesons and by cosmic rays in photographic emulsions. *See Abstr.* 600

537.591.8 : 539.172

469. On nuclear evaporation in cosmic rays and the absorption of the nucleonic component. II. G. Bernardini, G. Cortini and A. Manfredini. *Phys. Rev.*, **79**, 952–63 (*Sept.* 15, 1950).

For first part see Abstr. 2560 (1950). The nuclear evaporations produced by cosmic rays at 3 500 m were studied using Ilford C2 and Kodak NT4 plates. (1) The frequency of stars *v.* the number of prongs does not change very much in the transition between air and condensed materials. (2) The small transition effect observed in Pb is concentrated in the first few cm and is restricted to the small stars. (3) For greater thicknesses (of the order of the nucleon–nuclei geometrical range) the differences between paraffin and Pb seem to be negligible. (4) The differences between the Berkeley and the cosmic ray stars are concentrated in the large stars (more than 6 prongs). (5) The prongs of the small stars (less than 6 prongs) produced by cosmic rays show an angular distribution around the vertical to be expected from the Berkeley results. (6) The large stars show an isotropic distribution in the heavy prongs but not in the "grey" ones, and a correlation between the number of grey and the number of black prongs seems to be evident. (7) The energy spectrum of the black proton- and alpha-prongs is given with a statistic based on about 4 000 stars (average with every black prong about 35 MeV; average excitation corresponding to the black prongs emission about 150 MeV). (8) A comparison of the experimental proton spectrum with the Weisskopf–Bagge theory seems to show satisfactory agreement. (9) Similarly, the alpha-spectrum is in fairly good agreement with Le Couteur. (10) Some conclusions concerning the nuclear evaporations and the nucleonic cascade are discussed. A.

537.591.8 : 539.172

470. On nuclear evaporation in cosmic rays. G. Bernardini, G. Cortini and A. Manfredini. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 431–49 (1949).

The transition effects of the star size distribution in lead and paraffin are described and the relation of the size distribution of cosmic ray stars to that of stars from artificial primaries discussed. The relative numbers of "black" and "grey" tracks is discussed, and the contribution of each type to the angular distribution of star particles. The energy spectrum of protons and α-particles is considered in terms of the theoretical treatments of Bagge and Le Couteur. The contribution of π-mesons to star formation is also examined. [See also preceding Abstr. and Abstr. 4191 (1950)]. J. G. WILSON

537.591.8 : 539.18

471. The multiplicity of production and mass spectrum of cosmic ray mesons. R. B. BRODE. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 465–74 (1949).

(1) An improved magnetized-iron focusing telescope, which avoids the indeterminate high-energy background of the Bernadini apparatus is described. It yields a ratio of positive to negative mesons in the approximate momentum range $1{\cdot}0 < p < 2{\cdot}5$ BeV/c, $1{\cdot}32 \pm 0{\cdot}024$. The implications as regards the multiplicity of meson formation are discussed. (2) Measurements are reported of the range spectrum of the sea-level μ-meson beam up to 500 g cm^{-2} by means of a multiplate cloud chamber. The Rossi range spectrum, showing no significant reduction of intensity below 200 g cm^{-2}, is not confirmed. (3) A survey is given of the status of meson mass determination with special reference to the existence of a meson of mass $\sim 1\,000\ m_0$. J. G. WILSON

537.591.8 : 539.18

472. Meson formation in multiple processes. W. HEISENBERG. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 493–7 (1949) *In German.*

The leading quantities of the multiple process theory are summarized [see Abstr. 5553 (1949)], and the bearing of observations of Bernadini on showers in emulsions with negligible evaporation component, of Powell on the frequency distribution of stars with varying numbers of shower particles, and of Haxel on shower production in C and in C-equivalent paraffin, on the occurrence of multiple acts of meson formation, are examined. J. G. WILSON

537.591.8 : 539.18

473. The multiplicities of meson-showers and the absorption of meson-producing nucleons. W. HEITLER AND J. JANOSSY. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 499–508 (1949).

The extent to which existing evidence, and particularly the size distribution of thinly ionizing particle showers from stars in photographic emulsions, can be explained in a plural theory of meson formation is discussed. It is shown that even large showers are adequately described. The experimental data leads from this treatment to a reasonable cross-section of the elementary collision. The increase of the first slope of the penetrating shower transition curve with decreasing atomic number is shown to arise in any theory in which the nucleon cross-sections overlap within a nucleus; the effect is further complicated by the sensitivity of the main selecting layers of a penetrating shower apparatus to secondary events in the thick Pb shielding layers. J. G. WILSON

537.591.8 : 539.18

474. On the positive excess of mesons at sea-level. P. BASSI, E. CLEMENTEL, I. FILOSOFO and G. PUPPI. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 509–10 (1949) *In Italian.* See Abstr. 4193 (1950).

537.591.8 : 539.18

475. On the relative numbers of positive and negative μ-mesons at sea level. J. G. WILSON. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 523–4 (1949).

Momentum determinations on about 28 000 sea level cosmic-ray particles within 12° of the zenith allow values of the charge ratio of μ-mesons in the momentum range $1 < p < 8$ BeV/c to be given. The data for correcting the crude measurements for the presence of absorbable particles (protons) are quoted. The charge ratio shows a maximum value in the neighbourhood of $p = 3$ BeV/c.

J. G. WILSON

537.591.8 : 539.18

476. Production of the meson component. P. CALDIROLA. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 511–15 (1949) *In Italian.*

The spectrum of mesons and their charge ratio near sea level and at about 10 000 m altitude are deduced on the assumption that in the relevant energy range meson production is predominantly single (no multiplicity), that a constant fraction of the available energy is transferred to the created meson and that all possible distributions of energy between the two nucleons concerned are equally probable. J. G. WILSON

537.591.8 : 539.18

477. Production of high-energy mesons. B. D'ESPAGNAT. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 516–17 (1949) *In French.*

A treatment is given leading to the conclusion that multiple production of mesons will only become important at extremely high energies, and does not contribute to the apparent multiplicity of emulsion stars. J. G. WILSON

537.591.8 : 539.172

478. Some nuclear interactions of cosmic ray particles. E. P. GEORGE. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 531–4 (1949).

(1) The main star-producing radiation, consisting of neutrons of energy from 100 to 1 000 MeV, is of intensity 6% of the charged flux at sea level and 20% at Jungfraujoch. (2) The geometrical properties of a penetrating shower set of the Janossy type has been studied by operating with the producing layer of matter at different distances from the set. Comparison with emulsion data assigns an efficiency of the order 6% to 8% for the apparatus. (3) Nuclear events at a depth 60 m water equivalent are shown by a star production rate of the order $0{\cdot}01$ stars cm^{-3}day^{-1} and by the presence of small groups of penetrating particles detected by counter arrays. J. G. WILSON

537.591.8 : 539.18

479. An apparatus for the study of meson production in the stratosphere. M. CONVERSI AND H. K. TICHO. *Nuovo Cim.*, **7**, 677–89 (*July*, 1950) *In Italian.*

It is shown that at high altitude the apparatus allows one to recognize whether the locally produced mesons are π or μ-mesons and whether they are produced by ionizing or non-ionizing rays. Other results which may possibly be obtained by flying the instrument in a balloon are briefly discussed. A.

537.591.8 : 539.18

480. Slow mesons in the backward flux of the cosmic radiation. D. M. RITSON. *Proc. Phys. Soc., Lond. A*, **63**, 1098–100 (*Oct.*, 1950).

Using the method of "delayed coincidences" measurements have been made at sea level on the flux of slow mesons travelling backwards from the ground. A.

MAGNETISM 538

538.114

481. Generalizations of the Weiss molecular field theory of antiferromagnetism. P. W. ANDERSON. *Phys. Rev.*, **79**, 705–10 (*Aug.* 15, 1950).

A Weiss field calculation has been carried out for antiferromagnetism in more complicated structures than the usual calculation allows, and has been shown to give results more detailed and more consistent with experimental evidence on the magnetic properties of such structures than does the simpler theory. A.

538.114 : 538.22

482. On the theory of the formation of ferromagnetic superlattice alloys. H. SATO. *Sci. Rep. Res. Inst. Tohoku Univ., Ser. A*, **1**, 71–82 (*May*, 1949).

Previous theoretical work on assemblies exhibiting two cooperative phenomena [Abstr. 4084 (1949)], using a Bragg–Williams–Ising type of approximation, is extended. The method is applied to antiferromagnetic as well as ferromagnetic alloys; actual alloy systems are discussed and possible further extensions of the treatment indicated. E. P. WOHLFARTH

538.12

483. The teaching of physics: the difficulties of a definition of the magnetic field. G. GIORGI. *Ric. Sci.*, **20**, 925–6 (*July*, 1950) *In Italian.*

It is suggested that the magnetic flux should be considered as the primary magnetic quantity even in an elementary introduction to magnetism.

L. PINCHERLE

538.12 : 621.3.013

484. The magnetic field of a plane circular loop. C. L. BARTBERGER. *J. Appl. Phys.*, **21**, 1108–14 (*Nov.*, 1950).

The axial and radial components of the magnetic field of a plane circular loop are expressed in terms of cylindrical coordinates. The expressions involve two integrals which are related to certain of the complete elliptic integrals. Tables of values of these integrals are presented. Interpolation in these tables facilitates rapid calculation of the field components. A.

538.122

485. A note on magnetic fields in conducting materials. J. W. DUNGEY. Note in *Proc. Camb. Phil. Soc.*, **46** (*Pt* 4) 651–4 (1950).

A mathematical proof is given of the law that magnetic lines of force are frozen into highly conducting material. The case of the perfectly conducting fluid is considered and the estimation of the error due to finite conductivity in any particular application is discussed. A method of picturing the motion of the field by means of tubes of force is also mentioned. G. F. HODSMAN

538.214

486. Periodic field-dependence of the magnetic susceptibilities of metals at low temperatures. B. I. VERKIN, B. G. LAZAREV AND N. S. RUDENKO. Letter in *J. Exp. Theor. Phys., USSR*, **20**, 93–4 (*Jan.*, 1950) *In Russian.*

Comments on a paper by Rumer [Abstr. 1490 (1949)].

538.214

487. Periodic relation between the magnetic permeability and the field at low temperatures. YU. B. RUMER. Letter in *J. Exp. Theor. Phys., USSR*, **20** (*No.* 6) 573 (1950) *In Russian.*

In reply to Verkin, Lazarev and Rudenko (preceding Abstr.) a formula for the value of the characteristic field H_0 expressed by field strength H and the corresponding oscillation period of the permittivity ΔH is given, viz. $H_0 = 2H(H + \Delta H)/\Delta H = \text{const.}$ See also Abstr. 488 (1950). B. F. KRAUS

538.214 : 548.0

488. The crystallographic anisotropy of the de Haas–van Alphen effect. B. I. VERKIN, B. G. LAZAREV AND N. S. RUDENKO. *Dokl. Akad. Nauk, SSSR*, 73 (*No.* 1) 59–62 (1950) *In Russian.*

Measurements of the magnetic anisotropy in the basal planes of monocrystals of Zn and Be were made in uniform fields (H) of 3 000 to 14 500 oersted. At low temperatures the torque about the c-axes varied rapidly with azimuth showing a periodicity of 60°. Torque/azimuth diagrams also varied periodically and reproducibly with H. For Zn at 4·2°K this period was $\simeq$ 180 oer. at $H = 10\,500$ oer., and $\simeq$ 400 oer. at $H = 14\,200$ oer. For Be at 20·4°K the period was $\simeq$ 900 oer. at $H = 12\,000$ oer. No basal anisotropy was found in Zn crystals at 20·4°K and $H \leqslant 14\,500$ oer. but it became detectable at 4·2°K with $H \geqslant 9\,500$ oer. Be showed no basal anisotropy at 78°K. See also Abstr. 5123 (1950), 486 (1951).

A. L. MACKAY

538.22

489. Magnetic study of some silver salts. M. PRASAD, S. S. DHARMATTI, C. R. KANEKAR AND M. G. DATAR. *Proc. Indian Acad. Sci. A*, **31**, 389–99 (*June*, 1950).

Measurements have been made of the molar susceptibility, χ_M, of 21 organic and inorganic Ag salts and the value of χ_M for Ag^+ computed in each case. The mean value deduced from the data on organic salts is 31·75 and from those on inorganic salts 29·13 ($\times 10^{-6}$), the theoretical (Slater) value being 42·35; the ionic radius of Ag^+ deduced from the results is 1·62 (1·55) Å. The results of the measurements are compared with those on Cu and Au salts; for the chlorides a linear relation is obtained between χ_M and the number of electrons in the cations. E. P. WOHLFARTH

538.221

490. Magnetic resonance in antiferromagnetic materials near the Curie temperature. E. P. TROUNSON, D. F. BLEIL, R. K. WANGSNESS AND L. R. MAXWELL. Letter in *Phys. Rev.*, **79**, 542–3 (*Aug.* 1, 1950).

Experiments with Cr_2O_3 samples show that the height of the resonance absorption peak decreases abruptly on passing through the Curie point, 38°C, from the paramagnetic to the antiferromagnetic state. The amount of absorption below the Curie point was found to depend on the nature of the material, powdered specimens giving two peaks, one of which shifts with change in temperature, and sintered specimens giving an absorption which decreases to zero. The results are briefly discussed.

E. P. WOHLFARTH

538.221

491. Ferromagnetic resonance in manganese arsenide. G. D. Adam and K. J. Standley. Letter in *Proc. Phys. Soc., Lond. B*, **63**, 820–1 (*Oct.*, 1950).

Values of the *g*-factor were determined, by means of Kittel's relation, for 3 Mn–As specimens between 18° and 50°c. It was found that *g* did not vary appreciably on passing through the Curie point (ca. 40°c), the observed values being close to 3·8 over the whole temperature range. The fact that this value is abnormally large is noted.

E. P. WOHLFARTH

538.221 : 539.26

492. Deformations in the crystal structures of antiferromagnetic compounds. S. Greenwald and J. S. Smart. Letter in *Nature, Lond.*, **166**, 523–4 (*Sept.* 23, 1950).

It is pointed out that the temperatures at which slight deformations in the crystal structures of several iron group oxides have been observed [e.g. Tombs and Rooksby, *Nature, Lond.*, **165**, 442 (*March* 18, 1950)] are very close to the antiferromagnetic Curie temperatures of these oxides. Further X-ray observations confirm the identity of these two temperatures for CoO and Cr_2O_3. A qualitative interpretation of the results is given. E. P. WOHLFARTH

538.221 : 536.48

493. Low temperature ferromagnetism of sigma phase in an alloy steel. K. W. J. Bowen and T. P. Hoar. Letter in *Research, Lond.*, **3**, 484 (*Oct.*, 1950).

538.222

494. The magnetic anisotropy constant of highly coercive alloys. N. V. Bulgakov. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 4) 521–2 (1949) *In Russian.*

Investigation of an Alnico-steel monocrystal of sufficiently large dimensions (given the form of a sphere) by torsion dynamometer, to verify recent theoretical conclusions (cf. Kondorskiĭ, *Dokl. Akad. Nauk, SSSR*, **63**, 507 (1948)] on the shift of the boundaries between the domains in highly coercive materials which may be retarded up to magnetic field strengths corresponding to the reversal of the spontaneous magnetization of the material. Correspondingly, the coercive force of alloys must be determined by the crystallographic as well as by the magneto-elastic anisotropy (owing to the considerable internal elastic stresses in alloys). The experiments yielded two values for the constant of anisotropy, $1{\cdot}63\times10^5$ and $2{\cdot}3\times10^5$ erg/cm³; the difference is explained by the fact that the second value was obtained by considering only the initial term of a series representing the experimental curve. The agreement with theory is relatively satisfactory.

B. F. KRAUS

538.222

495. Paramagnetic susceptibilities of solid solutions of MnF_2 and ZnF_2. L. Corliss, Y. Delabarre and N. Elliott. *J. Chem. Phys.*, **18**, 1256–7 (*Sept.*, 1950).

The paramagnetic susceptibilities of solid solutions of MnF_2 and ZnF_2 have been measured as a function of temperature. The Curie–Weiss law $X = C/T + \Delta$ is obeyed by all the solutions examined over the temperature range 76°–295°K. The constant Δ was found to be a linear function of the mole fraction of MnF_2. This behaviour is consistent with the assumption that the magnetic interaction energy associated with a given ion is proportional to the number of its paramagnetic neighbours. A

538.222 : 538.569.4

496. Hyperfine structure and saturation effects in the paramagnetic resonance spectrum of manganese. T. S. England and E. E. Schneider. Letter in *Nature, Lond.*, **166**, 437 (*Sept.* 9, 1950).

Measurements of the paramagnetic resonance absorption at 9 501·5 Mc/s and about 3 500 gauss of Mn^{++} ions in 0·1% solution in ZnS phosphors shows 6 main hyperfine lines giving an interval of 0·006 cm^{-1} in the fine structure of the $^6S_{5/2}$ ground state and a *g* value of $2(1{\cdot}0012 \pm 0{\cdot}0002)$. Second-order splitting is observed at 0·001% Mn concentrations giving some 30 lines. Power saturation measurements at liquid air temperatures give a spin lattice relaxation time of 10^{-6} sec. D. H. WHIFFEN

538.222 : 539.154

497. Paramagnetic relaxation effects. A. H. Cooke. *Rep. Phys. Soc. Progr. Phys.*, **13**, 276–94 (1950).

The theories of spin-lattice relaxation and spin-spin relaxation are reviewed. Experimental methods are described. These relate to absorption measurements at radio frequencies, dispersion measurements and measurements at liquid He temperatures. The measurement and interpretation of magnetic specific heats are discussed. L. S. GODDARD

538.23

498. On the rectangular magnetic hysteresis loop of a ferromagnetic deformed in the temperature interval of recrystallization. M. V. Dekhtyar. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 4) 527–30 (1949) *In Russian.*

In polycrystalline ferromagnetics and in monocrystals the remagnetization process proceeds by small steps, and only in very rare cases can Barkhausen discontinuities of considerable amplitude be produced artificially. The most marked effects of this kind are obtained in ferromagnetics with a rectangular hysteresis loop. Such loops may be produced in Fe–Ni alloys by unilateral stresses, but for alloys without Ni it has hitherto proved to be impossible. It is shown by which treatment carbon-steel wires may be given nearly perfectly right-angled hysteresis loops. B. F. KRAUS

538.23

499. Ferromagnetic block. L. W. McKeehan. Letter in *Phys. Rev.*, **79**, 739 (*Aug.* 15, 1950).

This is defined as the region which is swept out by a domain boundary during its spontaneous travel between two minimum-energy positions, and is observable in the Barkhausen effect. This region may not itself be capable of existing as a stable domain. E. P. WOHLFARTH

538.23

500. Physical theory of ferromagnetic domains. L. W. McKeehan. Letter in *Phys. Rev.*, **79**, 745 (*Aug.* 15, 1950).

A brief criticism of a review article by Kittel, Abstr. 2563 (1950). E. P. WOHLFARTH

538.23

501. Ferromagnetic domains. H. J. WILLIAMS. *Elect. Engng, N.Y.*, **69**, 817–22 (*Sept.*, 1950).

A review article dealing especially with recent American experiments on powder patterns.

E. P. WOHLFARTH

538.23

502. Departure from the Rayleigh law of the magnetization of a ferromagnetic material. H. D. BUSH. Letter in *Nature, Lond.*, **166**, 401–2 (*Sept.* 2, 1950).

Experiments on the Barkhausen effect in Fe and Ni specimens are reported. The effect was found to be weak in the Rayleigh law region, owing to insufficient sensitivity of the apparatus used, but the number of discontinuities increased rapidly at and beyond the field at which the law ceases to hold. An explanation of the effects, based on current theoretical ideas on hysteresis, is given. E. P. WOHLFARTH

538.23.08 : 621.317.431

503. The tracing and interpretation of asymmetrical hysteresis loops. G. M. ETTINGER. Letter in *J. Appl. Phys.*, **21**, 936–7 (*Sept.*, 1950).

An arrangement is described for tracing directly on a cathode-ray tube (as the envelope of vertical lines) the curve of incremental permeability *v.* d.c. polarizing field (the "butterfly" curve).

538.244 : 621.318.24 : 621.3.014.1

504. Note on surface currents. P. BAUDOUX. *Bull. Acad. Roy. Belge Cl. Sci.*, **36** (*No.* 4) 340–7 (1950) *In French.*

A vector density of surface current is defined and the equation of continuity established. It is shown that this vector is the tangential discontinuity of the magnetic field, and that in a magnetized body the vector density of the equivalent surface current gives readily an expression for the intensity of magnetization. P. M. DAVIDSON (R)

538.245

505. Effect of inclusions on coercive force of iron. L. J. DIJKSTRA AND C. WERT. *Phys. Rev.*, **79**, 979–85 (*Sept.* 15, 1950).

Two contributing effects are examined: (1) the surface tension effect, and (2) the effect of internal magnetic poles. It is found that the coercive force depends both on the total volume fraction of inclusions and the state of dispersion. For a given composition of alloy, for particles both much larger and much smaller than the thickness of the domain wall, δ, the net contribution to the coercive force is small. The largest effect occurs for particles whose diameter is about equal to δ. Measurements have been made using a dispersion in iron of Fe_3C in the shape of spheres, the diameters of which could be varied over the desired range. The maximum effect on coercive force is found to occur for particles of size about 1 200 Å, indicating a value for δ of about this magnitude. For this value of d the measured value of the coercive force is found to agree well with the calculated value. A.

538.245

506. Ferromagnetism: magnetization curves. E. C. STONER. *Rep. Phys. Soc. Progr. Phys.*, **13**, 83–183 (1950).

This report deals mainly with work since 1934 on the variation with field of the magnetization of ferromagnetics and related phenomena. It is a continuation of an earlier report [Abstr. 2599 (1949)]. There are sections on single crystals, domain structure, the analysis of magnetization curves and magnetic materials, e.g. Fe–Si and Ni–Fe alloys, and permanent-magnet materials. An account is given of recent work on reversible and irreversible domain boundary movement and rotational processes, on the contribution of these to change of magnetization along magnetization curves, and on their relation to permeability, coercivity and remanence.

L. S. GODDARD

538.245

507. Domain structure of a cobalt–nickel crystal. R. M. BOZORTH AND J. G. WALKER. Letter in *Phys. Rev.*, **79**, 888 (*Sept.* 1, 1950).

538.245

508. High frequency permeability of ferromagnetic materials. R. MILLERSHIP AND F. V. WEBSTER. *Proc. Phys. Soc., Lond. B*, **63**, 783–95 (*Oct.*, 1950).

Methods are described for the measurement of resistive and inductive permeabilities over a range of frequencies from 150 to 10 000 Mc/s. The measurements of the resistive permeabilities were carried out by comparing the attenuation of a coaxial transmission line with the ferromagnetic as the inner conductor with that of a coaxial line having a non-ferromagnetic as inner conductor. The inductive permeabilities were obtained from the wavelength in a coaxial line having the ferromagnetic as the inner conductor. The results show that at all frequencies the resistive permeability is greater than the inductive, and both decrease to unity at very high frequencies. The effective permeability, which is assumed to be complex, is deduced as a function of resistive and inductive permeabilities and plotted against frequency for a variety of materials. The experimental values are compared with theoretical values derived from two formal treatments. A.

538.27

509. Influence of ageing on the shape of the curve of temperature-dependence of the coercive force in dynamo steel. YA. S. SHUR AND K. B. VLASOV. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 4) 551–3 (1949) *In Russian.*

By ageing is meant the variation of the absolute values of the coercive force in time at a comparatively low temperature rise (so that recrystallization and relaxation processes are still negligible) and it is intensified by a preliminary heating to 700–800°C. At a subsequent heating under vacuum to above 200° and keeping at this temperature, a considerable increase of the coercive force in time is noticed. The curve obtained between $-200°$ and about $+500°$C is fairly symmetrical, with a maximum in the region of the Curie point. This agrees with the theoretical interpretation of the minimum of the saturation magnetostriction along the crystallographic axis (100) and its subsequent rise between 470° and 500°.

B. F. KRAUS

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

510. A repetition of Oersted's researches, in which metallic particles with six degrees of freedom were used in place of a magnetic needle. J. A. SCHEDLING. *Acta Phys. Austriaca*, **4** (*No.* 1) 98–117 (1950) *In German.*

Photographs were obtained of the paths of small metallic particles (10^{-3} to 10^{-5} cm) suspended in air and N, in the magnetic field caused by a d.c. current. In many cases the motion is that of an isolated N or S magnetic pole; no particles moved like dipoles.

N. CORCORAN

538.3

511. The motion of metallic test particles of order of magnitude 10^{-4} to 10^{-5} cm in the homogeneous magnetic field from a permanent magnet, under intermittent illumination. J. A. FERBER. *Acta Phys. Austriaca*, **4** (*No.* 1) 133–43 (1950) *In German.*

The particles were either Cr or omega-Fe, and moved in the direction of the magnetic field on being illuminated; some only moved if illuminated; some moved in the dark and moved faster if illuminated, and some moved independently of the illumination. The particles showing the greatest effect behaved like isolated magnetic poles of strength 10^{-11} c.g.s. units.

N. CORCORAN

538.3

512. An electro-magnetic problem. G. F. C. SEARLE. *Brit. J. Appl. Phys.*, **1**, 268–9 (*Oct.*, 1950).

A manageable form of a problem put to Oliver Heaviside in 1916 is solved. A pair of concentric spheres, of radii a, b, and centre O, carry charges q and $-q$. A pole m moves along OX and gives rise to electric force in circles round OX. The pair of spheres experiences a resultant couple J, of axis OX. The pole experiences no couple. The force on the medium is $d(V\mathbf{DB})/dt$ per unit volume, where **D** is electric displacement and **B** is magnetic induction. This force, like **D**, is null except between the spheres. The total couple due to it amounts to $-\mathbf{J}$. A.

538.3 : 53.081.4

513. Rational and non-rational treatment of the electromagnetic field. U. STILLE. *Abh. Braunschw. Wiss. Gesell.*, **1**, 38–55 (1949) *In German.*

The question of a rational or non-rational way of writing of equations, definition of quantities and fixing of units is formulated in general and represented for source- and vortex fields. In order to characterize this geometrical alternative, "corresponding coefficients" without dimension are introduced which are to be put equal to 1 or to 4π in the rational or non-rational case. The transition rational $\rightleftharpoons$ non-rational may be carried out in general according to the method of variation of quantities as well as variation of units. The description of the force of attraction between masses, in use since Newton, proves non-rational. Sets of equations for the 4 ways of writing most important in practice (rational, partly rational according to Maxwell or Gauss, and non-rational according to Schaefer). A.

538.3 : 53.081.4

514. Equations with 3, 4 and 5 fundamental quantities in electrodynamics. U. STILLE. *Abh. Braunschw. Wiss. Gesell.*, **1**, 56–75 (1949) *In German.*

On a system of equations containing 3 fundamental quantities the various modes of treatments introducing electrostatically, electromagnetically and symmetrically defined quantities are discussed in detail and the relations of connection between these 3 kinds of quantities and the respective quantities of the system with 4 fundamental quantities are developed and compiled. Moreover, the alternative, rational/non-rational (see preceding Abstr.) is inserted in these relations. The transition from one system to another may be carried out according to the method of variation of quantities and variation of units; the second method fails in case of transition from the system with 4 fundamental quantities to the symmetrical one with 3 fundamental quantities. General equations are given for the system with 5 fundamental quantities from which equations between numerical values result, if the field constants ε_0 and μ_0 and the quantity $\gamma = c_0\sqrt{(\varepsilon_0 \times \mu_0)}$ are disposed of in a certain physical meaning according to unit and numerical value. Making use of the geometrical "corresponding coefficients" one may obtain, from this system with 5 fundamental quantities, all required rational or non-rational ways of writing of systems with 5, 4 and 3 fundamental quantities. A.

538.51 : 621.3.011 : 621.392.

515. Circuit analysis of linear varying-parameter networks. L. A. ZADEH. *J. Appl. Phys.*, **21**, 1171–7 (*Nov.*, 1950).

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.566 : 538.52

516. Ordinary and evanescent e.m. waves caused by plane distributions of charge and current. S. GIBELLATO. *Nuovo Cim.*, **7**, 606–25 (*July*, 1950) *In Italian.*

When a non-uniform e.m. wave is incident upon a perfectly conducting plane, it induces on it charges σ and currents j which are the cause of the reflected wave. σ and j move with a phase velocity which may vary between 0 and ∞, and the field generated by them consists of two (ordinary or evanescent) waves.

L. PINCHERLE

538.566 : 621.396.11

517. On the reflection of electromagnetic waves at a discontinuity in the permittivity gradient. G. ECKART. *Funk u. Ton*, **4**, 354–7 (*July*, 1950). Also in *Z. angew. Phys.*, **2**, 334–7 (*Aug.*, 1950) *In German.*

A mathematical treatment of the reflection at a plane boundary between two regions both with the same permittivity at the boundary, but with the permittivity uniform in one and having a linear variation in a direction perpendicular to the boundary in the other. It is concluded that it is not the gradient which is important but the rate of change of permittivity with wavelength. J. M. HOUGH (R)

538.566 : 621.396.677

518. Diffraction of spherical electromagnetic waves on a paraboloid of rotation of limited size when the exciting field has a dipole perpendicular to the axis of symmetry of the paraboloid. R. G. MIRIMANOV. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 6) 1021–3 (1949) *In Russian.*

538.566.2 : 621.3.011 : 621.392.2

519. Surface waves and their application to transmission lines. G. GOUBEAU. *J. Appl. Phys.*, **21**, 1119–28 (*Nov.*, 1950).

538.566.2 : 621.392.26 : 621.3.011

520. Artificial field equations for a region where μ and ϵ vary with position. P. D. P. SMITH. *J. Appl. Phys.*, **21**, 1140–9 (*Nov.*, 1950).

The field equations developed, for regions of zero conductivity, are symmetrical with respect to electric and magnetic quantities, and the TM case can be derived from the TE. Fields derivable from a single component 4-potential are examined, and their propagation equations are found. A table relates the tensor and pseudo-tensor components to the usual vector components. Applications are investigated in cylindrical polar coordinates. For the TE case, 3 types of solution exist, called A, B or C, where the E field is parallel to the elementary vectors **dz, dr** or **rdθ**, respectively (for the TM case, **H** replaces **E**). In each TM or TE case, two possible distributions of μ and ε occur, leading to separable propagation equations. TEM waves can be derived from both TM and TE cases, but the impedances are different. TE, TM and TEM waves for certain specific distributions of μ and ε, and their applications to curved guides, horns and co-axial lines are considered. Some expressions are obtained for the fields, propagation constants, cut-off frequencies and impedance. These solutions are not necessarily of the most general type, for to meet the conditions that restrict their choice, μ and ε are taken to be independent of the coordinate to which the transverse component of **E** (in TE) or **H** (in TM) is parallel. A.

538.566.2 : 621.396.671

521. Effect of a circular groundplane on antenna radiation. A. LEITNER AND R. D. SPENCE. *J. Appl. Phys.*, **21**, 1001–6 (*Oct.*, 1950).

The field of a $\lambda/4$ aerial above a circular conducting disc of zero thickness—the groundplane—is calculated theoretically by use of the wave functions of the oblate spheroid. Assuming a sinusoidal distribution of current on the aerial a calculation is made of the currents on the groundplane, the radiation resistance and the radiation pattern of the system for various values of the radius a. With these results the distortion of aerial radiation by finite groundplanes can be studied. Good agreement is found with recent experimental data. A.

538.566.2 : 621.396.671

522. Theory of axially slitted circular and elliptic cylinder antennas. D. R. RHODES. *J. Appl. Phys.*, **21**, 1181–8 (*Nov.*, 1950).

A method proposed by Sommerfeld for solving boundary-value problems involving discontinuous surfaces has been applied to the general case of a plane electromagnetic wave of arbitrary direction of incidence and polarization diffracting about one or more sections of perfecting conducting circular and elliptic cylinders of infinite length. The solution is in series form, where the series coefficients are independent for the special case of slots of infinitesimal width (slits). Radiation from the slitted cylinder is restricted to discrete right circular cones about the cylinder axis, each cone corresponding to an ordinary waveguide mode in the cylinder, while slots of finite width radiate over a continuous range of conical angles. For slots of small but finite width, the relative pattern in the cone $\alpha = \alpha_0$ about a circular cylinder of radius a is the same as in a plane normal to the axis of a cylinder of radius $a \sin\alpha_0$; patterns of the slotted elliptic cylinder are similarly related, where the analogue of radius is distance between foci. Conical patterns are shown for the principal *TE* and *TM* waveguide modes in circular cylinders containing one and two diametrically opposed axial slits. A.

538.566.2 : 621.396.671.4

523. The effect of input configuration on antenna impedance. J. R. WHINNERY. *J. Appl. Phys.*, **21**, 945–56 (*Oct.*, 1950).

A region in the vicinity of the input is here considered as a transducer between the TEM-mode on the driving transmission line and the spherical nearly-TEM mode on the aerial system, and the constants of this transducer are found both by calculation and measurement for a particular case. The calculation is based upon quasi-static concepts, utilizing an electrostatic field map obtained from an electrolytic tank to give the approximate form of the electric field lines. The measurement is made by finding 3 input reactances corresponding to the input region closed by 3 spun Al hemispheres of different radii. The 3 sets of data, taken at each frequency, are sufficient to determine the constants of the transducer. They are expressed here as a π-network for comparison with calculated values. The main portion of the aerial is analysed substantially as in Schelkunoff's approach with the TM modes in space and in the aerial region expressed as a shunt admittance at the end of the aerial in the TEM mode equivalent circuit. This admittance is then transformed to the desired reference on the aerial by a perturbation calculation. From there it is transformed to a desired reference on the feed line by means of the input network constants. Values calculated in this way are compared with measured values over the range 200 to 1 000 Mc/s for the particular monopoles studied. Agreement is not perfect, but appears considerably better than without consideration of the specific input configuration. A.

MAGNETIC EFFECTS 538.6

538.61 : 537.228

524. Theory of magneto-photophoresis, of helical motion, and of electrophotophoresis. P. TAUZIN AND J. CREUSOT. *C.R. Acad. Sci. Paris*, **231**, 614–16 (*Sept.* 25, 1950) *In French.*

Magnetophotophoresis is interpreted in terms of collisions between molecules and the suspended particles, the latter being oriented by the magnetic

field. It is assumed that each particle has particular regions where molecules are most likely to collide, and the impacts account for the observed helical orbits. A similar theory accounts for electrophotophoresis. N. CORCORAN

538.63

525. On the magneto-resistance of thin ferromagnetic films. A. DRIGO. *Nuovo Cim.*, **7**, 527–9 (*July*, 1950) *In Italian.*

Measurements were made on Ni films, thickness $\sim 10^{-6}$ cm. The longitudinal effect, for $H >$ 1 500 oersteds, was found to be negative; the opposite to that observed in bulk material. The changes in $\Delta R/R$ were smaller than those observed in bulk material since changes in the magnetization of the film could occur only by rotation. In high field strengths the variation of $\Delta R/R$ with field strength, both for the transverse and longitudinal field directions, showed approximately the same gradient as the bulk material. H. P. MYERS

MOLECULAR STRUCTURE 539.13

539.13 : 548.0

526. Polypeptide chain configurations in crystalline proteins. L. BRAGG, J. C. KENDREW AND M. F. PERUTZ. *Proc. Roy. Soc. A*, **203**, 321–57 (*Oct.* 10, 1950).

Many models of folded and coiled polypeptide chains were constructed, with a view to finding those satisfying conditions of steric possibility, chemical probability and compatibility with the Patterson syntheses of proteins, particularly myoglobin and haemoglobin. These conditions were best met by (i) a model constituted according to the proposal of Astbury and Bell, having a 2 screw axis and 13 amino-acid residues between C═O . . . H bonds, and (ii) a similar model with 14 amino-acid residues between C═O . . . H bonds. Many of the models showed considerable flexibility, however, and the superiority of these two is not overwhelming.

A. J. C. WILSON

539.132

527. The dissociation energies of the nitrogen molecule and its significance for the afterglow of active nitrogen. G. CARIO AND L. H. REINECKE. *Abh. Braunschw. Wiss. Gesell.*, **1**, 8–13 (1949) *In German.*

The dissociation energies of the N molecule proposed by Herzberg (7·38 eV), Gaydon (9·76 eV) and Schmid and Gerö (5·0 eV) are discussed. The potential curve of the N_2-ground state $X^1\Sigma_g^+$ has been determined by means of the Rydberg-method up to a vibration energy of 6·5 eV. The extrapolation of the experimentally founded curve with Morse- and Hulburt- and Hirschfelder-functions leads to a dissociation energy of $D_{N_2} = 9{\cdot}76$ eV. Applying this value, the recombination of two normal ^4S-atoms is considered responsible for delivering the energy of the afterglow of active N. The relation between intensity of the afterglow and temperature can be explained by a recombination process, which lead over the predissociation limit to the $B^3\Pi_g$-state. A

539.132

528. The vibration-rotation energies of the plane symmetrical $X_2Y_2X_2$ molecular model. R. C. HERMAN AND W. H. SHAFFER. *J. Chem. Phys.*, **18**, 1207–11 (*Sept.*, 1950).

The quantum-mechanical calculation of the rotation-vibration energies of the plane symmetrical $X_2Y_2X_2$ molecular model is carried out to 2nd-order approximation so as to include contributions arising from cubic and quartic anharmonic terms in the potential function, Coriolis interactions, centrifugal stretching, and changes in the rotational constants produced by vibration. A

539.132

529. Polarizability and internuclear distance in the hydrogen molecule and molecule-ion. R. P. BELL AND D. A. LONG. *Proc. Roy. Soc. A*, **203**, 364–74 (*Oct.* 10, 1950).

The polarizability of the H molecule-ion has been calculated for a range of internuclear distances, using various types of wave-functions. It is concluded that the values obtained for the polarizability are relatively insensitive to the choice of wave-function. Similar calculations have been made for the H molecule, using an LCAO wave-function. The value obtained for the polarizability at the equilibrium internuclear distance is in fair agreement with experiment and with the results of earlier calculations. The predicted variation of polarizability with internuclear distance agrees approximately with that deduced previously from the refractivities of H and D but is greater than that derived from the observed intensities of Rayleigh and Raman scattering. A

539.132

530. Molecular orbital predictions of organic spectra. J. R. PLATT. *J. Chem. Phys.*, **18**, 1168–73 (*Sept.*, 1950).

The energies of the first 2 to 5 electronic transitions of 16 conjugated molecules are predicted as simple one-electron LCAO molecular orbital transitions (with overlap included). Assignments of the observed levels to the predicted levels are made. Qualitative agreement is good when $S = 0{\cdot}25$ and $\beta = 23\,000$ cm^{-1} for ring systems. It is shown that configuration interaction must be introduced to modify these energy predictions and to account for the intensities in some molecules ("round-field") such as benzene, triphenylene, coronene and porphine. This interaction is less important in other molecules ("long-field") such as pyrene, biphenyl and tetrahydroporphine. Empirical groupings of intensities and luminescence lifetimes are shown for the different singlet-singlet and singlet-triplet band types of round-field hydrocarbons and for related molecules containing conjugated hetero-atoms. The alteration of these groupings in long-field molecules, and under *jj* coupling, is described. A

539.132

531. Molecular orbital calculations on porphine and tetrahydroporphine. H. C. LONGUET-HIGGINS, C. W. RECTOR AND J. R. PLATT. *J. Chem. Phys.*, **18**, 1174–81 (*Sept.*, 1950).

The first 3 electronic transitions of porphine and

the first 5 electronic transitions of tetrahydroporphine are predicted as simple one-electron *LCAO* molecular orbital transitions (with overlap included). The electron densities and bond orders in the ground states are also computed. The observed levels are tentatively assigned to the predicted levels with the help of comparisons with spectra of other aza-amine derivatives of conjugated hydrocarbons. Probable degeneracies and polarizations are determined. The blue shift and loss of intensity of the first electronic transition, in going from tetrahydroporphine to the larger conjugated system of porphine, is typical of the change from a "long-field" to a "round-field" molecule (see previous Abstr.) and is shown to occur in several other "long-field" systems when additional conjugated atoms are added at the side of the system. A.

539.132 : 535.338.4 : 551.593.9

532. Anomalous molecular rotation and the temperature of the upper atmosphere. L. M. Branscomb. *Phys. Rev.*, **79**, 619–26 (*Aug.* 15, 1950).

This experiment verifies the prediction of Oldenberg that the spectroscopically measured rotational temperature of a diatomic gas will be lower than the translational temperature when (1) the pressure is low, (2) the gas is excited by electron impact, and (3) the excited electronic state from which the measured bands are radiated has an equilibrium nuclear separation greater than the internuclear distance in the ground state. For gas temperatures from 400 to 670°K rotational temperatures from the 2nd negative bands of O_2^+ were found in qualitative agreement with the predicted relation $T_{rot} = T_{trans}\, B'/B''$. Upper atmosphere temperatures derived from band profiles in night sky spectra are consistently lower than temperatures estimated from other data. The possible occurrence of anomalous rotation of the night sky molecules casts some doubt on the meaningfulness of the night sky temperature measurements. A partial rotational analysis in the course of this experiment suggests revisions of the B_0 and α-values for the O_2^+ molecule in the $^2\Pi_u$- and $^2\Pi_g$-states. A.

539.132 : 541.4

533. The theoretical treatment of the monosilan molecule. J. I. Horváth. Letter in *J. Chem. Phys.*, **18**, 1115 (*Aug.*, 1950).

The binding energy of SiH_4, an 18-electron problem, is determined by a method previously described [Abstr. 2640–1 (1949)]. A new feature is that Si has two closed shells, apart from 4 valence electrons, whose interaction with the protons is taken into account. The minimum energy occurs at $R = 1{\cdot}58$ Å, R = distance of protons from Si nucleus; experimental value $R = 1{\cdot}5$ Å. J. JACOBS

539.132 : 541.57

534. On the translation into the method of molecular orbitals of electronic links between non-adjacent atoms. A. Laforgue. *C.R. Acad. Sci., Paris*, **231**, 439–41 (*Aug.* 16, 1950) *In French.*

Orbitals of π-type extend over a molecule consisting of an atom X (electronic configuration sp^2) linked to t ($\leqslant 3$) atoms Y at the corners of a triangle. The resonance integral β for XY becomes $\lambda = 0{\cdot}2\,\beta$ for YY, if it varies with distance as R^{-3}; similarly the overlap S for XY becomes $L = 0{\cdot}2S$ for YY. Application without overlap to $t = 2$ (ozone) gives a small dipole moment. In complex molecules charges are more affected than bond orders. J. JACOBS

539.132 : 541.5?

535. The C–Br bond dissociation energy in benzyl bromide and allyl bromide. M. Szwarc, B. N. Ghosh and A. H. Sehon. *J. Chem. Phys.*, **18**, 1142–9 (*Sept.*, 1950).

The pyrolysis of organic bromides in a stream of toluene is described as a method for the determination of the C–Br bond dissociation energies. The technique used makes it possible to discriminate between two mechanisms of decomposition: (*a*) R . Br → R . + Br, (*b*) R . Br → olefin + HBr. It was found that both benzyl and allyl bromide decomposed according to mechanism (*a*), the Br atoms reacting readily with toluene to give HBr. The rate of the primary dissociation process was measured by the rate of formation of HBr. It was proved that the thermal decompositions of benzyl and allyl bromide were homogeneous gas reactions obeying 1st-order kinetics. The activation energies were calculated at $50{\cdot}5 \pm 2$ kcal/mole and $47{\cdot}5 \pm 2$ kcal/mole and identified with $D(C_6H_5 . CH_2 - Br)$ and $D(CH_2 : CH . CH_2 - Br)$, respectively. The values for these dissociation energies, combined with the heats of formation of the relevant bromides in the gaseous state, make it possible to determine the heats of formation of various organic radicals. Furthermore, the latter data in conjunction with the heats of formation of hydrocarbons enable us to calculate the various C–H and C–C bond dissociation energies and the resonance energies of the relevant radicals. A.

539.133 : 541.4

536. The role of molecular vibrations in chemical reactivity. J. Duchesne. Letter in *J. Chem. Phys.*, **18**, 1120–1 (*Aug.*, 1950).

This note suggests that reactivity may be conditioned in certain cases by twisting vibrations of molecules (as in ethylene but not in acetylene). The argument is further extended to substitution reactions and the case of the substitution of ethylene by halogens is briefly discussed. J. D. CRAGGS

539.133 : 551.594.5

537. Possibility of measuring a quadrupole transition probability from an auroral afterglow. K. G. Emeléus, N. D. Sayers and R. A. Bailey. Letter in *Nature, Lond.*, **166**, 656–7 (*Oct.* 14, 1950).

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

538. Significance of special (magic) numbers of nucleons in nuclear structure in terms of a model. O. Haxel, J. H. D. Jensen and H. E. Suess. *Z. Phys.*, **128** (*No.* 2) 295–311 (1950) *In German.*

See Abstr. 7193 (1949), 1914–15 (1950). A full discussion in empirical terms of a single-particle model with a potential intermediate between a square

well and a parabola (isotropic oscillator). A strong spin-orbit coupling, increasing with the orbital momentum of a single nucleon, is assumed. The treatment is almost identical with that given simultaneously by Mayer [Abstr. 1911, 6006, 6007 (1950)]. It is shown that the magic numbers arise naturally from completion of shells. The properties of nuclei with uncompleted shells are discussed in detail. Agreement between predicted and experimental values of spins and magnetic moments is shown to be very good on the whole. Apparent anomalies can be used to furnish information on the extent of the spin-orbit splitting. The appearance of isomeric states, indicating the juxtaposition of levels with large and small angular momenta, is readily explained. There is evidence that the antiparallel pairing of nucleons in states of high orbital momenta can modify the normal sequence of levels. The spins and magnetic moments of doubly odd nuclei can be accounted for if one assumes a parallel combination of the momenta of the odd neutron and proton. β-transitions are not discussed at length as they have been dealt with by others [Abstr. 5604 (1949), 1910 (1950)]. Limitations of the model are suggested in large magnetic dipole and electric quadrupole moments that point to deformations of the nuclear core in whose field the single particle is assumed to move. A. P. FRENCH

539.152.1

539. Evidence for favoured nuclear structures. G. J. Béné, P. M. Denis and R. C. Extermann. *Helv. Phys. Acta*, **23** (*No.* 5) 493–500 (1950) *In French.*

A summary of the experimental evidence for the "magic numbers" of nuclear structure is presented, including evidence from nuclear moments, α- and β-radioactivity, delayed neutron emission and fission [Abstr. 6005 (1950)]. W. J. SWIATECKI

539.152.1

540. On statistical models of nuclei. G. Puppi. *Nuovo Cim.*, **7**, 703–4 (*July*, 1950) *In Italian.*

It is known that in a perturbation calculation of the binding energy of heavy nuclei starting from a Fermi distribution at 0°K, 2nd-order terms are important and improve agreement with experiment. On the other hand, this suggests that perturbation methods are inadequate. It is shown in this preliminary paper that, if one starts from a Fermi distribution at a finite temperature, one term is added to the first approximation, which may improve agreement with experiment, while the importance of the 2nd-order terms is reduced. L. PINCHERLE

539.152.1

541. Special and magic numbers as factors in nuclear stability and abundance. W. D. Harkins. Letter in *Phys. Rev.*, **79**, 724–5 (*Aug.* 15, 1950).

539.152.1

542. Order of magnitude theory of the depression of Coulomb barrier height in highly excited nuclei. Y. Yamaguchi. Letter in *Progr. Theor. Phys.*, **5**, 501–2 (*May–June*, 1950).

539.152.1

543. Nuclear shell structure and nuclear density. M. Born and L. M. Yang. Letter in *Nature, Lond.*, **166**, 399 (*Sept.* 2, 1950).

An explanation of the formation of closed shells in nuclei is sought for in the behaviour of degenerat systems of particles with spin one half. With reason able assumptions as to the density distribution withi a nucleus the closed shells can be accounted for. J. HUGHE

539.152.

544. On the lower levels of He^5. H. Goldstein Letter in *Phys. Rev.*, **79**, 740 (*Aug.* 15, 1950).

539.152.1 : 537.533.7

Scattering of electrons by nuclei. *See Abstr.* 374–5

539.152.1 : 539.155.2 : 535.338.33

545. The Fierz and Kopfermann–Brix explanatio of the spectroscopic odd-even isotope shift staggering G. Breit. Letter in *Phys. Rev.*, **79**, 891 (*Sept.* 1, 1950)

539.152.

546. Precision determination of nuclear gyro magnetic ratios. E. W. Guptill, W. J. Archibald and E. S. Warren. *Canad. J. Res. A*, **28**, 359–6 (*July*, 1950).

The ratios of the Larmor frequency of precessio for H and F, and for Na and Al have been measure with an accuracy of one part in 10^5: $\nu_H/\nu_F = 1{\cdot}062917 \pm 0{\cdot}00001$, $\nu_{Na}/\nu_{Al} = 1{\cdot}015081 \pm 0{\cdot}0000$ These ratios are corrected for the atomic diamagnetism giving for, γ, the nuclear gyromagnetic ratios $\gamma_H/\gamma_F = 1{\cdot}06245 \pm 0{\cdot}00002$, $\gamma_{Na}/\gamma_{Al} = 1{\cdot}01494 \pm 0{\cdot}00002$. A brief description is given of the relevan equipment used in obtaining these measurements. A

539.152.

547. Remarks on the quasi-atomic model and nuclea magnetic moments. R. Bouchez. *C.R. Acad. Sci. Paris*, **231**, 275–7 (*July* 24, 1950) *In French.*

The failure of the vector model of the nucleus t account for the magnetic moments of nuclei is attri buted to the fact that nuclear states are not pure, bu mixtures of states with different angular momentu but the same parity. Agreement between calculate and experimental values for nuclear magnetic moment is obtained using this hypothesis. J. HUGHE

539.152.2 : 548.

548. Nuclear electric quadrupole interactions i crystals. R. V. Pound. *Phys. Rev.*, **79**, 685–70 (*Aug.* 15, 1950).

A study is made of the effects of the presence o nuclear electric quadrupole moments on the nuclea magnetic resonance absorption in solids. Necessary theoretical background is followed by descriptions o experiments in which the spectra obtained with a r-f spectrograph, described elsewhere, are found t show marked splitting resulting from the quadrupole interaction with the electric field gradient. Both powder patterns and spectra of single crystals are reported, for Li^7, Na^{23} and Al^{27}, with splittings varying from about 20 kc to 718 kc, depending on the crystal and the nucleus. Unambiguous indication of the spin values is obtained. The possibility of the detection of a resonance resulting from the electric quadrupole splittings in the absence of a static magnetic field is discussed. A method is described o determining the frequency of a large electric quadrupole splitting. The electric quadrupole moment is shown probably to account for relaxation times o nuclei of spin greater than $\frac{1}{2}$ even in cubic crystals

and, as evidence, resonances of Na^{23}, Li^{7}, I^{127} and Br^{81} are reported. Assuming partial saturation and electric quadrupolar relaxation, calculations are made to account for a departure of the intensity ratios of the lines, in the Na^{23} spectrum in $NaNO_3$, from the ratios of the transition probabilities for magnetic dipole radiation. The possibility of determining nuclear electric quadrupole moments from splittings or relaxation times in ionic crystals is discussed. A.

539.153

549. On the energy levels of the configurations d^4p, d^5p and d^6p. T. Ishidzu and S. Obi. *J. Phys. Soc., Japan*, **5**, 124–42 (*May–June*, 1950).

The electrostatic energy matrices of the configurations d^4p, d^5p and d^6p were calculated by Racah's method of tensor operators. The results for the last configuration were compared with the observed values by J. C. Dobbie for Fe II, $3d^64p$. A.

539.153

550. Structure of the f^n electron configurations. I. Coefficients of fractional parentage of f^3. T. Ishidzu and S. Obi. *J. Phys. Soc., Japan*, **5**, 142–4 (*May–June*, 1950).

Racah's theory of the structure of the equivalent electron groups was applied to the f^n configurations. The coefficients of fractional parentage of f^3 terms were determined in this paper, and the electrostatic energies were re-calculated in $v\alpha SL$ scheme. A.

539.153

551. Structure of the f^n electron configurations. II. Spin-orbit interaction of the configuration f^3. T. Ishidzu and S. Obi. *J. Phys. Soc., Japan*, **5**, 145–8 (*May–June*, 1950).

Utilizing the C.F.P. for f^3 terms obtained in the preceding article, the matrices of the spin-orbit interaction have been calculated in $v\alpha SL$ scheme. The results would be applicable to the spectra of Nd atoms. A.

539.153

552. Some new relations in the interval factors and the general case of the l^r electron configuration. V. Ramakrishna Rao. *Indian J. Phys.*, **24**, 257–60 (*June*, 1950).

An investigation of the regularities in the multiplet separations in spectral terms due to p^n, d^n and f^n electron configurations has led to the formulation of two new theorems. These enabled the calculation of multiplet separations for certain terms in any configuration of the type l^r, thus avoiding the laborious work involved in Goudsmit's method. The theorems are stated and their *a priori* proofs are presented. Using these theorems, the separation factors are calculated for certain terms in f^4, f^5, f^6 configurations. A.

539.153

553. Multiplet separations in the f^4-electron configuration. K. Suryanarayana Rao. *Indian J. Phys.*, **24**, 296–302 (*July*, 1950).

The separation factors are calculated for the multiplet terms of the f^4-electron configuration, using Goudsmit's method. A table of the results is given. All the terms are predicted to be normal with the exception of ^3D. A.

539.153

554. Fine structure of the hydrogen atom. I. W. E. Lamb, Jr. and R. C. Retherford. *Phys. Rev.*, **79**, 549–72 (*Aug.* 15, 1950).

A beam of atoms in the metastable $2^2S_{1/2}$ state is produced by bombarding atomic H. The metastable atoms are detected when they fall on a metal surface and eject electrons. Subjected to radiofrequency power of the proper frequency, these atoms undergo transitions to the non-metastable states $2^2P_{1/2}$ and $2^2P_{3/2}$ and decay to the ground state $1^2S_{1/2}$ in which they are not detected. Thus, contrary to the predictions of the Dirac theory, the $2^2S_{1/2}$ state does not have the same energy as the $2^2P_{1/2}$ state, but lies higher by an amount corresponding to a frequency of about 1 000 Mc/s. Within the accuracy of the measurements, the separation of the $2^2P_{1/2}$ and $2^2P_{3/2}$ levels is in agreement with the Dirac theory. No differences in either level shift or doublet separation were observed between H and D. Much more accurate measurements will be reported in subsequent papers as well as a detailed comparison with the quantum electrodynamic explanation of the level shift by Bethe. Among the topics discussed are (1) spectroscopic observations of the H_α line, (2) early attempts to use microwaves to study the H fine structure, (3) existence of metastable H atoms, their properties and methods for their production and detection, (4) estimates of yield and r-f power requirements, (5) Zeeman and hyperfine structure effects, (6) quenching of metastable H atoms by electric and motional electric fields, (7) production of a polarized beam of metastable H atoms. [See also Abstr. 3606 (1947)]. A.

539.153.1 : 541.65

555. Optical rotation and atomic dimension. D. H. Brauns. *Rec. Trav. Chim. Pays-Bas*, **69**, 1175–95 (*Sept.–Oct.*, 1950).

From measurements of the optical rotations of F, Cl, Br, I substitutes of acetyl sugars and of optically active alcohols two rules are derived connecting the differences in optical rotation with the differences of atomic diameter. A.

539.153.4

556. The mutual repulsive potential between argon atoms. M. Kunimune. *Progr. Theor. Phys.*, **5**, 412–27 (*May–June*, 1950).

Bleick and Mayer developed a method for treating the repulsive interaction of 2 closed shells, and determined the interaction of two Ne atoms. In the present paper the same method was applied to calculate the repulsive potential in the case of two A atoms, the one-electron atomic wave functions that were obtained numerically by Hartree being used. The value of the repulsive potential at $R = 3{\cdot}70\times10^{-8}$ cm is $6{\cdot}20\times10^{-14}$ ergs; at $R = 2{\cdot}64\times10^{-8}$ cm is 328×10^{-14} ergs; and at $R = 2{\cdot}12\times10^{-8}$ cm is 2090×10^{-14} ergs. These 3 values are fitted by the simple function $b\exp(-R/p)$ with small errors as expected. A.

539.153.4

557. The repulsive potential of normal helium atoms. P. Rosen. *J. Chem. Phys.*, **18**, 1182–6 (*Sept.*, 1950).

The repulsive potential between two normal He

atoms is calculated using the bond eigenfunction method. It is found that Slater's potential, $V(R) = 770 \exp(-2{\cdot}43R/a_0) \times 10^{-12}$ ergs, must be multiplied by a factor of 2·1 in the region of the minimum of the total potential. By extrapolating to $R = 0$, the energy of Be in the ground state is found to be − 29·4 Rhc units. A.

539.154

558. Quantum-mechanical interpretation of Kohlrausch's "natural system of screening constants and effective quantum numbers." O. THEIMER. *Acta Phys. Austriaca*, **4** (*No.* 1) 1–8 (1950) *In German.*

It is shown that Kohlrausch's empirical method [Abstr. 8172 (1950)] is equivalent to expressing the wave function of the atom as the simple product of electronic wave functions of the Slater type.

L. PINCHERLE

539.154 : 535.338.332

559. Sommerfeld's fine-structure constant and the problem of spectroscopic units. J. BRANDMÜLLER AND E. RÜCHARDT. *Naturwissenschaften*, 37 (*No.* 15) 337–43 (1950) *In German.*

A discussion of recent spectroscopic determinations of the fine structure constant α is given. From spectroscopic values of α, R_H, R_D, "spectroscopic" values are deduced for h, e, m, which agree with non-spectroscopic measurements. A review is given of attempts to derive a theoretical formula for α, or theoretical relations between α and other dimensionless constants. L. PINCHERLE

539.154.3

560. Atomic moments of ferromagnetic alloys. R. M. BOZORTH. Letter in *Phys. Rev.*, **79**, 887 (*Sept.* 1, 1950).

539.155.2

561. Mass spectrometer measurements on argon from potassium salts. M. PAHL, J. HIBY, F. SMITS AND W. GENTNER. Letter in *Z. Naturforsch.*, **5a**, 404–5 (*July*, 1950) *In German.*

The A content of various K-containing salts was corrected for pollution by atmospheric A by mass spectrometric measurements. A. O. STANESBY

539.155.2 : 537.534.72 : 621.389

562. Improvements in mass spectrometers for the measurement of small differences in isotope abundance ratios. C. R. MCKINNEY, J. M. MCCREA, S. EPSTEIN, H. A. ALLEN AND H. C. UREY. *Rev. Sci. Instrum.*, **21**, 724–30 (*Aug.*, 1950).

A Nier-type mass spectrometer and its associated electronic units have been constructed for the purpose of measuring small variations in the abundances of O of mass 18 and of C of mass 13 in CO_2, and of O of mass 18 in O gas, to an accuracy of $\pm 0{\cdot}01\%$ of the abundance of these isotopes. The electronic units of the necessary stability for this degree of accuracy are described; also a gas feed system which permits fast alternate introduction of the sample of gas to be analysed and a standard gas into the mass spectrometer. All measurements of the variation in the abundance of the O and C isotopes are made with reference to a standard. A.

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

563. The measurement of radioactive hydrogen in solid samples—comparison with gas counting. M. L. EIDINOFF AND J. E. KNOLL. *Science*, **112**, 250–1 (*Sept.* 1, 1950).

It is shown that solid compounds of tritium suitably plated out on an Al pan can be measured with a methane-flow type windowless counter operated in proportional region. Disadvantage of solid counting procedure arises from low energy of β-rays of tritium leading to infinite thickness of 0·82 mg/cm². Advantages over measurement as gas or volatile compound are time saving and that the compound is not destroyed in analysis. T. A. CHALMERS

539.162

564. Nature of the beta decay of H^3. M. E. VOIKHANSKI, B. S. DZHELEPOV AND L. A. SLIV. *Dokl. Akad. Nauk, SSSR*, **66** (*No.* 5) 829–32 (1949). English transl. in *Guide Russ. Sci. Period. Lit., Brookhaven*, **2**, 355–8 (*Nov.*, 1949).

The values of τf for H^3 are calculated on various assumptions of the mass of the neutrino, making corrections for the Coulomb factor. These are all $\sim 1\,000$, and significantly lower than the mean value of 3 500 obtained for the group ${}_ZM^{2Z-1}$ of β^+ emitters. The product $|M|^2\tau f$, however, is found to be in satisfactory agreement with that from the above group for the tensor and pseudovector forms of interaction. B. ROSE

539.163

565. The isotopes of americium. K. STREET, JR., A. GHIORSO AND G. T. SEABORG. Letter in *Phys. Rev.*, **79**, 530–1 (*Aug.* 1, 1950).

New activities and further information about known activities are reported: Am^{238}?, ½-life ca. 1·2 hr, emitting conversion electrons and X-rays (orbital electron capture?) produced by Pu^{239} $(d, 3n)$; Am^{239}, branching ratio α/orbital electron capture ca. 0·01%; α-particle energy 5·77 ± 0·05 MeV; Am^{240}, ½-life 50 hr, decays by orbital electron capture; no α-particles observed, produced by Pu^{239} (d, n); Am^{241}, ½-life 475 yr; Am^{242}, long-lived isotope emitting α-particles (partial ½-life ca. 100 yr) and β-particles (partial ½-life ca. 10^4 yr, energy 0·575 ± 0·010 MeV); produced by Am^{241} (n, γ); Am^{242m}, ½-life 16 hr, β-particle energy 0·630 ± 0·005 MeV; Am^{243}, α-particle energy 5·21 ± 0·03 MeV, partial α ½-life ca. 10^4 yr, possible partial β^- ½-life $< 10^3$ yr, produced by Am^{241} $(2n, \gamma)$; Am^{244}?, ½-life ca. 25 min, emitting β-particles, produced by Am^{243} (n, γ).

A. O. STANESBY

539.163

566. New radioactive isotopes of iridium. T. C. CHU. *Phys. Rev.*, **79**, 582–9 (*Aug.* 15, 1950).

Four new isotopes of Ir have been prepared by bombarding isotope-enriched Re as well as natural Re with alpha-particles, and Os with deuterons. Three of them have been identified as Ir^{187}, Ir^{188} and Ir^{190}, having half-lives of 11·8 hr, 41·5 hr and 3·2 hr respectively. The 3·2 hr period is an isomer of the 12·6 day Ir^{190}. Another weak activity, possibly Ir^{189},

of more than 100 day half-life has been observed. Four daughter activities of Ir (9·5 min, 6 hr, 35 hr and ca. 50 day radio Os) have been found, and their possible genetic relations discussed. A Re activity of ca. 1 hr half-life has been noticed in the Os + 19 MeV deuteron experiment. A.

539.163

567. Radioactive isotopes of gadolinium. R. E. Hein and A. F. Voigt. *Phys. Rev.*, **79**, 783–6 (*Sept.* 1, 1950).

A 236 day neutron-induced activity in Gd purified by ion exchange methods is assigned to Gd^{153}. The activity decays by *K*-electron capture emitting a 106 keV γ-ray giving rise to *K*- and *L*-electron groups. A 7·2 ± 0·2 day and approximately 24 hr activity present in the neutron-bombarded Gd were separated on an ion exchange column. The 7·2 day activity assigned to Tb^{161} decays by emission of 0·50 MeV β-particles. The 24 hr activity is tentatively assigned to Gd^{159}. Half-life measurements on Gd produced by deuteron bombardment of Eu extend over 600 days. The activity decaying with a half-life of 155 days initially is slowly lengthening into a longer half-life. A 265 keV γ-ray is detected in addition to the 106 keV γ-ray previously found in Gd^{153}. The 265 keV γ-ray is assigned to Gd^{151} which decays with a half-life of 150 days. This half-life is based on ratios of the 106 keV γ-ray to the 265 keV γ-ray observed over a 600 day period. A.

539.163

568. Radioactive isotopes of the rare earths. III. Terbium and holmium isotopes. G. Wilkinson and H. G. Hicks. *Phys. Rev.*, **79**, 815–18 (*Sept.* 1, 1950).

See Abstr. 4935, 4943 (1949). A study has been made of neutron-deficient radioactive isotopes of Tb and Ho produced respectively by α-particle bombardments of Eu and Tb, and respectively by proton bombardments of Gd and Dy, using the 60 in Crocker Laboratory cyclotron. Five new isotopes of each element have been characterized. A.

539.163

569. A new long-lived krypton activity. J. H. Reynolds. Letter in *Phys. Rev.*, **79**, 886–7 (*Sept.* 1, 1950).

539.163

570. Disintegration of Ru^{103}. E. Kondaiah. Letter in *Phys. Rev.*, **79**, 891–2 (*Sept.* 1, 1950).

539.163

571. The radiations of Ce^{141} and Pa^{223}. M. S. Freedman and D. W. Engelkemeir. Letter in *Phys. Rev.*, **79**, 897–9 (*Sept.* 1, 1950).

539.163

572. Radiations of krypton^{85}. H. Zeldes, B. H. Ketelle and A. R. Brosi. Letter in *Phys. Rev.*, **79**, 901–2 (*Sept.* 1, 1950).

539.163

573. Radioactivity from enriched isotopes of cadmium. J. M. Cork, W. C. Rutledge, A. E. Stoddard, C. E. Branyan and J. M. LeBlanc. *Phys. Rev.*, **79**, 938–40; (*Sept.* 15, 1950).

By irradiating in the pile specimens of Cd enriched in mass 108 and in mass 114, it is possible to interpret more positively the observed radioactivities and to evaluate the gamma-rays associated with each. Cd 109 produced by neutron capture in Cd 108 decays with a half-life of approximately 250 days by *K*-capture to Ag 109 in which a strong gamma-ray of 87·5 keV is emitted. Cd 115 is isomeric with half-lifes of 54 hours and 42·6 days, both isomers decaying to In 115 by beta-emission. The 54 hour activity yields many gamma-rays in In whose energies are 335·5, 343·7, 348·9, 369·3, 423·7, 451·9, 525·4, 559·1 and 713·1 keV. These gamma-energies fit well a proposed nuclear level scheme in In 115. A.

539.163.1

574. A precision determination of the half-life of radium C′. G. von Dardel. Letter in *Phys. Rev.*, **79**, 734–5 (*Aug.* 15, 1950).

539.163.1

575. The half-life of iodine^{131} and the anomalous decay of exposed sodium iodide sources. W. K. Sinclair and E. W. Emery. *Brit. J. Radiol.*, **23**, 576–8 (*Sept.*, 1950).

The half-life of I^{131} has been determined as 8·02 ± 0·03 days. Exposed sources of NaI decay more rapidly owing to loss of active material, but this effect is not observed when the iodide is precipitated with $AgNO_3$. A.

539.163.2

576. A new selenium nuclear isomer of $\frac{1}{2}$ life 3·9 min. A. Flammersfeld and C. Ythier. Letter in *Z. Naturforsch.*, **5a**, 401 (*July*, 1950) *In German.*

The new activity was produced by bombarding Se in thin layers with fast or slowed neutrons from the Be + D or Li + D reactions ($E_D = 1·4$ MeV); it decays with the emission of electrons of 90 ± 10 keV energy (range in Al ~ 9·5 mg/cm²) and is attributed to Se^{77*}, Se^{79*} or Se^{81*}. The electrons associated with the 17·5 sec isomeric transition of Se^{77*} were found to have an energy of ~ 0·165 MeV (range in Al ~ 30 mg/cm²), and the $\frac{1}{2}$-life was 17·4 ± 0·15 sec. The high-energy β-activity of Se^{83} with $\frac{1}{2}$-life of 1·1 min [Abstr. 401 (1948)] was also confirmed.

A. O. Stanesby

539.163.2

577. Energy levels associated with Se^{75}. J. M. Cork, W. C. Rutledge, C. E. Branyan, A. E. Stoddard and J. M. Le Blanc. Letter in *Phys. Rev.*, **79**, 889 (*Sept.* 1, 1950).

539.163.2

578. The assignment of 1·1 hr lead. K. Geiger. Letter in *Z. Naturforsch.*, **5a**, 401–3 (*July*, 1950) *In German.*

The 1·1 hr lead activity is attributed to Pb^{205} (probably decaying by *K*-capture) rather than to Pb^{204*} since it can be produced by bombardment of Pb by thermal and In-resonance neutrons.

A. O. Stanesby

539.163.2

579. Some disintegration schemes by the coincidence method. G. A. Renard. *Ann. Phys., Paris*, **5**, 385–450 (*July–Aug.*, 1950) *In French.*

A general discussion of coincidence absorption methods for the study of decay schemes is given. Apparatus used for this work is described, including a coincidence arrangement of two open-ended counters mounted inside a glass vessel, permitting the elimination of all solid absorber between a source and the

sensitive volumes of the counters. Expts. on V^{52} are described, from which it was deduced that (*a*) the β-spectrum is simple, (*b*) there is only one energetic γ-ray, (*c*) the ratio of the no. of β-rays to the no. of quanta is $0{\cdot}65 \pm 0{\cdot}1$. These results provoked a search for conversion electrons and low-energy quanta. Soft electrons (~ 250 keV) were discovered, but coincidences between these and the β-rays were not observed. No evidence for soft γ-rays could be found. The results could be explained if the method used for production of V^{52} (slow neutron capture in V^{51}) led to an isomeric state as well as to the ground state. Measurements of the ratio of slow to fast electrons as a function of the neutron irradiation time and of the time after the end of irradiation suggested that $\sim 1/6$ of the nuclei would be present in the metastable state under prolonged irradiation. The known period (3·74 m) of V^{52} [Abstr. 757 (1948)] is ascribed to the metastable state; a value of $2{\cdot}55 \pm 0{\cdot}10$ m is deduced for the ground state. Similar measurements on Au^{198} supported the idea of a simple β-spectrum, though not excluding a branching of $\sim 10\%$. No evidence for γ-rays in cascade was obtained, nor for *K*-capture more frequent than $\sim 1\%$. A final section discusses the efficiencies of γ-counters. Curves of efficiency *v.* energy for counters with walls of Al, Cu, Pb or Au embody earlier results together with some new measurements by the author. A. P. FRENCH

539.163.2

580. On the isomerism of Kr^{85}. I. Bergström and S. Thulin. Letter in *Phys. Rev.*, **79**, 537 (*Aug.* 1, 1950).

The β- and γ-ray spectra of 4·5 hr Kr^{85} were studied with a β-spectrometer. γ-rays of 149 and 300 keV were found, together with an allowed β-ray of 817 keV. From coincidence measurements it was inferred that the 300 keV γ-ray represents the isomeric transition in Kr^{85}. The other γ-ray is ascribed to an isomeric transition in Rb^{85}. With the aid of the observed lifetimes, branching ratios and internal conversion coefficients 3 possible sets of angular momentum and parity values for the participating levels are deduced. One set is consistent with a shell model of the nucleus [Abstr. 1914, 6006 (1950)], viz. $(\frac{1}{2}, -)$ for Kr^{85*}, $(\frac{9}{2}, +)$ for Kr^{85}, $(\frac{3}{2}, -)$ for Rb^{85*}, $(\frac{5}{2}, -)$ for Rb^{85}. A. P. FRENCH

539.163.2

581. On the decay of Xe^{133m}. I. Bergström and S. Thulin. Letter in *Phys. Rev.*, **79**, 538–9 (*Aug.* 1, 1950).

Measurements and analysis of the type described for Kr^{85} (preceding Abstr.) were carried out for Xe^{133} and suggest the following designations for the levels involved: $(\frac{3}{2}, +)$ for Xe^{133*}, $(\frac{11}{2}, -)$ for Xe^{133}, $(\frac{5}{2}, +)$ for Cs^{133*}, $(\frac{7}{2}, +)$ for Cs^{133}. Accurate values of the β- and γ-ray energies are tabulated. From observations on Auger electrons produced in the transitions, the fluorescence yield in the *K*-shell for Cs was found to be $0{\cdot}89 \pm 0{\cdot}08$. A. P. FRENCH

539.163.2

582. A mass spectrometric investigation of branching in Cu^{64}, Br^{80}, Br^{82} and I^{128}. J. H. Reynolds. *Phys. Rev.*, **79**, 789–94 (*Sept.* 1, 1950).

Gram quantities of the elements in question were subjected to prolonged irradiation in a graphite moderated pile and were allowed to cool. The occurrence of negatron emission in the induced activities was identified with the presence in the irradiated sample of decay products of atomic number $Z + 1$; positron emission and orbital electron capture, with the presence of decay products of atomic number $Z - 1$. The amounts of these decay products were determined by adding to a solution of the irradiated sample, as tracers, weighed milligram amounts of the daughter elements in a form isotopically different from the radiogenic material. When isotopic mixing had occurred, the daughter elements were isolated for mass spectrometric analysis. In such a procedure, quantitative recovery is unnecessary; the branching ratio can be determined from the change in the isotopic constitution of the tracers. A.

539.163.2 : 537.533.72

The design of a magnetic focusing coincidence spectrometer. *See Abstr.* 367

539.164.2 : 539.166

583. Angular correlations of short-range alpha particles and gamma quanta. L. A. Kulchitski, G. D. Latyshev and D. G. Bulyginski. *Guide Russ. Sci. Period. Lit., Brookhaven*, **3**, 219–27 (*Aug.*, 1950).

Complete translation of Russian paper of Abstr. 3369 (1950). See also Abstr. 5636 (1949).

539.165

584. Radioactivity of scandium^{44}. J. A. Bruner and L. M. Langer. *Phys. Rev.*, **79**, 606–9 (*Aug.* 15, 1950).

An unusual beta-ray spectrum had previously been reported [Abstr. 2386 (1942)]. Sc^{44} was prepared according to the reaction $K^{41}(\alpha, n)Sc^{44}$, and the activity was examined in two 180° focusing, shaped magnetic field spectrometers. A single positron group ($E_0 = 1{\cdot}463 \pm 0{\cdot}005$ MeV; $T_{\frac{1}{2}} = 4{\cdot}0 \pm 0{\cdot}1$ hr) was found; the Fermi plot of its momentum distribution has the allowed shape. The positron decay is fed by an isomeric transition ($E = 271{\cdot}3 \pm 0{\cdot}7$ keV; $T_{\frac{1}{2}} = 57 \pm 2$ hr) and is followed by a gamma-ray ($E = 1{\cdot}16 \pm 0{\cdot}01$ MeV) to the ground state of Ca^{44}. No positron transition directly to the ground state was observed. Evidence was found for a high proportion of *K*-capture to the excited state of Ca^{44}. A.

539.165

585. Beta-decay of Ag^{111} and spin-orbit coupling in Cd^{111}. S. Johansson. Letter in *Phys. Rev.*, **79**, 896–7 (*Sept.* 1, 1950).

539.165

586. Argon^{39} beta-spectrum. A. R. Brosi, H. Zeldes and B. H. Ketelle. Letter in *Phys. Rev.*, **79**, 902 (*Sept.* 1, 1950).

539.165 : 539.166

587. The disintegration of In^{116}. H. Slätis, S. J. du Toit and K. Siegbahn. *Ark. Fys.*, **2**, *Paper* 30, 321–32 (1950).

It decays with the emission of a complex β-ray spectrum with 3 components, maximum energies 1·00, 0·87 and 0·60 MeV, with relative intensities 51%, 28% and 21% resp. The Sn^{116} formed emits 6 γ-rays of 0·137, 0·406, 1·085, 1·274, 1·487 and 2·090 MeV. A previously reported γ-ray at 1·8 MeV was not found. A level scheme is proposed and

checked by coincidence experiments. Internal conversion coefficients for the three γ-rays at 0·406, 1·085 and 1·274 MeV, indicate that these are electric quadrupole transitions. J. HUGHES

539.165 : 539.166

588. Radiations from Os^{185}, Os^{191}, and Os^{193}. M. E. BUNKER, R. CANADA AND A. C. G. MITCHELL. *Phys. Rev.*, **79**, 610–15 (*Aug.* 15, 1950).

The radiations from Os^{185} (97 days), Os^{191} (32 hr) and Os^{193} (15 days) have been investigated with the help of a magnetic lens spectrometer. Os^{185} decays by orbital electron capture accompanied by 2 gamma-rays of energy 0·648 and 0·878 MeV. The number of gamma-ray quanta of 0·648 MeV is 6 times that of 0·878 MeV. Os^{191} decays by the emission of beta-rays of maximum energy 1·10 MeV and does not appear to be accompanied by any gamma-rays. Os^{193} decays by beta-particle emission accompanied by 2 gamma-rays of energy 0·128 and 0·041 MeV. The beta-ray spectrum is obscured by internal conversion and Auger lines. The end point is approximately 0·135 MeV. A.

539.165 : 539.166

589. Beta-gamma angular-correlation experiments. J. R. BEYSTER AND M. L. WIEDENBECK. Letter in *Phys. Rev.*, **79**, 728–9 (*Aug.* 15, 1950).

539.165 : 539.166

590. Further investigation of the radioactivity of Sb^{124}. L. M. LANGER, R. D. MOFFAT AND H. C. PRICE, JR. *Phys. Rev.*, **79**, 808–12 (*Sept.* 1, 1950).

The shape of the highest energy beta-ray group in Sb^{124} is found to have a forbidden shape that is characteristic of a once-forbidden transition involving a change of 2 units of angular momentum and a change of parity. As a consequence, the end points of the 3 highest energy groups are changed somewhat to $2{\cdot}291 \pm 0{\cdot}005$, $1{\cdot}69 \pm 0{\cdot}01$ and $0{\cdot}95 \pm 0{\cdot}03$ MeV. A high-resolution measurement of photo-electrons confirms the existence of the 0·607, 0·653 and 0·730 MeV gamma-rays. The internal conversion of the 0·607 MeV gamma-ray was studied. The character of the radiation and relation of the parity assignments to possible predictions of the nuclear shell model are discussed. A search for possible positron or *K*-capture transitions to Sn^{124} gave no indication of the existence of such radiation. A.

539.165.2

591. Electron conversion of gamma quanta in beta decay. I. S. SHAPIRO. *Dokl. Acad. Nauk, SSSR*, **67** (*No.* 1) 53–5 (1949). English trans. in *Guide Russ. Sci. Period. Lit., Brookhaven*, **2** (*No.* 12) 385–8 (*Dec.*, 1949).

The case is considered of a beta-transition to an excited state of the daughter nucleus, the probability of the transition to the ground state being vanishingly small for Fermi field interactions. A new process is discussed in which, by the electromagnetic interaction of the electron and excited nucleus, the electron carries away the excitation energy. The probability of this effect is found to be very small. B. ROSE

539.165.2

592. On the evaluation of the Fermi β-distribution function. H. HALL. Letter in *Phys. Rev.*, **79**, 745 (*Aug.* 15, 1950).

539.165.2.08

593. Absolute determination of the emission rate of beta-rays. R. K. CLARK. *Rev. Sci. Instrum.*, **21**, 753–9 (*Aug.*, 1950).

The method consists of measuring the rate at which charge is carried away from the active material by the emitted electrons. The effects of ionization are eliminated by placing the material in a high vacuum. The effects of the surroundings (excluding the parts required to support the active material) are reduced by using a tank of large dimensions, and the magnitude of these effects is determined by the use of supplementary surrounding surfaces with various potentials applied to them. Some information is obtained about the effects of the source-supporting structures by placing over the active side of the source-supporting foil a cover foil identical to it. A.

539.166

594. Disintegration of $_{56}Ba^{131} \rightarrow {}_{55}Cs^{131} \rightarrow {}_{54}Xe^{131}$. E. KONDAIAH. *Ark. Fys.*, **2**, *Paper* 28 295–304 (1950).

Ba^{131} was prepared by irradiation of Ba nitrate in a pile. γ-rays of energies 122 ± 2, 206 ± 4, 372 ± 3 and 494 ± 6 keV were inferred from the electron-spectrum and from the photo-spectrum, in disagreement with other results [Abstr. 1611 (1947)]. Electron-electron coincidences were investigated in the spectrometer, and γ–γ coincidences with gold-lined Geiger counters. A decay scheme is proposed, and, from their internal conversion coefficients, all the γ-rays are estimated to be either electric quadrupole or magnetic dipole. B. ROSE

539.166

595. Radioactive isomers of Sn^{117} and Sn^{119}. J. W. MIHELICH AND R. D. HILL. *Phys. Rev.*, **79**, 781–3 (*Sept.* 1, 1950).

The 14-day Sn^{117m} activity has been found to consist of two transitions: 159 keV of multipole order 5, and 162 keV of multipole order 2. An activity $\sim$ 250-day half-life has been assigned to Sn^{119m} and a transition of 69 keV, multipole order 5, has been observed. A.

539.166

596. Internal conversion coefficients of Sc^{46}. M. L. MOON, M. A. WAGGONER AND A. ROBERTS. Letter in *Phys. Rev.*, **79**, 905–6 (*Sept.* 1, 1950).

NUCLEAR REACTIONS 539.17

539.172

597. Emission of heavy fragments in nuclear explosions. D. H. PERKINS. *Proc. Roy. Soc. A*, 399–417 (*Oct.* 10, 1950).

Observations have been made on the energetic nuclear fragments emitted in "giant" cosmic-ray stars. The disintegrations were produced in the heavy nuclei of Ilford C2 and G5 emulsions exposed at high altitude. Methods are described for the identification of the fragments, both stable and unstable, with charges between 3 and 10 units. It is found that fragment emission may be interpreted in terms of an

asymmetric fission process, which is highly probable when the nuclear excitation energy becomes comparable with the binding energy. The average kinetic energies of the fragments are considerably greater than those to be expected from the Coulomb repulsion, a fact which may be explained in terms of specifically long-range nuclear forces. The fragments exhibit a peculiar tendency to be emitted in directions perpendicular to the incident star-producing particle. The mass of the emitted fragment does not depend appreciably on the size of star. At present there appears to be no comprehensive theoretical explanation of the precise mechanism of emission of such particles. A.

539.172 : 537.591.8

Nuclear evaporation in cosmic rays. *See Abstr.* 469

539.172 : 537.591.8

598. Nuclear transmutations produced by cosmic particles of great energy. C. F. POWELL. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 379–88 (1949).

See Abstr. 6317 (1949), 1060, 3235, 6622 (1950).

J. G. WILSON

539.172 : 537.591.8

599. Nuclear events of very high energy in cosmic rays. L. LEPRINCE-RINGUET. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 389–95 (1949) *In French.*

The technique of exposing photographic emulsions at uniform heights of the order 20 000 m is discussed. Two large stars are considered: one, neutron-produced, from the point of view of the multiplicity of meson formation in a single encounter; the other, due to a heavy primary, as bearing on the problem of the break-up of colliding heavy nuclei. J. G. WILSON

539.172 : 537.591.8

600. Nuclear evaporation and other phenomena produced by high energy neutrons, α particles, deuterons, π-mesons and by cosmic rays in photographic emulsions. P. CÜER, L. VAN ROSSUM AND M. MORAND. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 399–401 (1949) *In French.*

Detailed studies of stars produced by 80 MeV neutrons are discussed and the small stars produced by cosmic rays at 1 275, 2 500, 3 475 and 30 000 m and by π^- capture are compared with those produced by homogeneous primaries of known energy.

J. G. WILSON

539.172 : 537.591.8

601. Nature of particles emitted in nuclear explosions at high energies. D. H. PERKINS. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 453–54 (1949).

Examination of the heavily ionizing (> 7 min) particles of 200 cosmic-ray stars from heavy nuclei in emulsions leads to the conclusions: (1) in small stars the energy distribution and angular distribution of protons and α-particles are consistent with evaporation; (2) in larger stars this is no longer true for α-particles; (3) the ratio of α-particles to protons has a maximum at about 9 branches; (4) heavier nuclei, observed up to $Z = 10$ and $E \sim 300$ MeV, are emitted both in ground and in excited states. The latter disintegrate, and the divergence of the fragment cone leads to an estimate of excitation energy. Most heavy particles are emitted with energy in excess of the Coulomb barrier potential.

J. G. WILSON

539.172.11

602. Fission excitation functions for charged particles. J. JUNGERMAN. *Phys. Rev.*, **79**, 632–40 (*Aug.* 15, 1950).

Absolute fission excitation functions have been measured with an ionization chamber to detect the pulse of a recoiling single fragment. In the experiment performed, the 60 in Crocker cyclotron deuterons and alpha-particles were used with Th^{232}, U^{235} and U^{238} targets. Thresholds of these reactions were also observed. The maximum alpha-particle energy used was 33·5 MeV and the maximum deuteron energy was 17·5 MeV. Beam current was integrated with a Faraday cup and an ionization chamber. The 184 in synchrocyclotron was used to extend the fission excitation functions to alpha-particle energies of 390 MeV and deuteron energies of 193 MeV. Bi^{209} and Au^{197} targets were also added. Preliminary results with protons of 340 MeV maximum energy are also reported. A.

539.172.11

603. Energy levels in C^{12} from $Be^9(\alpha, n)C^{12}$. W. H. GUIER AND J. H. ROBERTS. Letter in *Phys. Rev.*, **79**, 719–20 (*Aug.* 15, 1950).

539.172.13

604. Fission of medium weight elements. R. E. BATZEL AND G. T. SEABORG. Letter in *Phys. Rev.*, **79**, 528 (*Aug.* 1, 1950).

Evidence is presented for a process in which elements of medium weight are split into several fragments of comparable weight under bombardment by high energy protons. Cl^{38} was observed after 60–70 MeV proton bombardment of Cu^{63}; the threshold for $Cu^{63}(p, pn6\alpha)Cl^{38}$ is about 100 MeV, but that for $Cu^{63} + p \rightarrow Cl^{38} + Al^{25} + n$ is about 50 MeV. Similarly, 180 MeV protons are required to produce $Br^{79}(p, p7n7\alpha)Sc^{44}$, whereas the threshold for $B^{79} + p \rightarrow Sc^{44} + P^{34} + 2n$ is about 80 MeV. Sc^{44} was observed when Br was bombarded by protons of 125 MeV and 140 MeV, with cross-sections $\sim 10^{-32}$ cm^2. Bombardments of Ag and Sn were also studied, the latter giving a positive result. In all cases, targets of high purity were used, and tests for the effects of impurities were made by radio-activation methods. Product nuclei were identified by half-life measurement and determination of the sign of beta-emission, after chemical separation.

T. G. PICKAVANCE

539.172.13

605. The excited nuclear state of Be^7. G. D. FREIER, T. F. STRATTON AND L. ROSEN. Letter in *Phys. Rev.*, **79**, 721–2 (*Aug.* 15, 1950).

539.172.13

606. Magnetic analysis of the $B^{10}(p, \alpha)Be^7$ reaction. D. M. VAN PATTER, A. SPERDUTO, E. N. STRAIT AND W. W. BUECHNER. Letter in *Phys. Rev.*, **79**, 900–1 (*Sept.* 1, 1950).

539.172.13

607. Li^8 splinters from nuclear bombardments. S. C. WRIGHT. *Phys. Rev.*, **79**, 838–45 (*Sept.* 1, 1950).

Li^8 has been produced by 340 MeV proton and 190 MeV deuteron bombardments of C, N, Ne, A, Kr and Xe. The target element formed the gas of a proportional counter. The 0·88 sec beta-decay of Li^8 produces Be^{8*} which disintegrates into two alpha-

particles with a half-life of 10^{-21} sec. Li^8 was detected by observation of these alpha-particles and identified by its half-life. Deuteron excitation functions for the production of Li^8 are given for C, N, Ne and A. In the case of 190 MeV deuterons the cross-section varies from about 13×10^{-28} cm² for C to 4×10^{-29} cm² for Xe. For 340 MeV protons the variation is from about 7×10^{-28} cm² for C to 3×10^{-29} cm² for Xe. A discussion of the process involved is given. A.

539.172.13

608. Reaction constants for $T^3(p,n)He^3$. G. A. JARVIS, A. HEMMENDINGER, H. V. ARGO AND R. F. TASCHEK. *Phys. Rev.*, **79**, 929–35 (*Sept.* 15, 1950).

Measurements of the differential and total cross-sections for $T^3(p,n)He^3$ between the reaction threshold at 1·019 MeV and 2·49 MeV are reported. At the higher energies the neutron emission in the centre-of-mass system is highly asymmetric and the energy dependence of the coefficients of a cosine expansion fit to the angular distribution is determined. Evidences for resonance effects are observed at the highest proton energies used, indicating an excited state in the continuum of the intermediate He^4 nucleus. The use of the reaction as a neutron source is discussed. A.

539.172.13

609. Thin target yield of $O^{18}(p,\alpha)N^{15}$. C. MILEIKOWSKY AND R. T. PAULI. Letter in *Nature, Lond.*, **166**, 602 (*Oct.* 7, 1950).

539.172.13

610. Angular distribution of protons in reactions $O^{16}(d,p)O^{17}$ and $Al^{27}(d,p)Al^{28}$. YU. A. NEMILOV AND B. L. FUNSHTEIN. *Dokl. Akad. Nauk, SSSR*, **66** (*No.* 4) 609–12 (1949) [Transl. in *Guide Russ. Sci. Period. Lit. Brookhaven*, **2** (*No.* 11) 351–4 (1949)].

Disintegration protons emerging from a target at angles between 30° and 130° to a deuteron beam were allowed to fall on a photographic film after passing through a wedge absorber. In this way a continuous range of absorber thickness was presented to the protons at every angle. A microphotometer analysis of the film then showed steps corresponding to different proton groups, so that angular distributions for the groups could be plotted separately. The angular distribution for $O^{16}(d,p)$ was measured at deuteron energies of 2·6 and 3·9 MeV. Protons associated with the ground state and the first excited state of O^{17} were observed and had almost identical angular distributions with strong forward maxima. [This disagrees with Heydenburg and Inglis, Abstr. 1315 (1948)]. The process $Al^{27}(d,p)$ was studied at 3·9 MeV deuteron energy and 5 groups of protons were found; the smaller the energy release in the (d,p) process, the larger the forward component in the corresponding angular distribution. The results can be understood in terms of the theory of stripping processes [Abstr. 743 (1948), 692 (1949)]. A. P. FRENCH

539.172.13

611. The angular distribution of the D–D neutrons. I. BARTHOLDSON. *Ark. Fys.*, **2**, *Paper* 25, 271–5 (1950).

The neutrons were observed at 5 angles between 0° and 90° with respect to the deuteron beam for bombarding energies from 50 to 200 keV. A target of heavy ice was used, and the detector was a BF_3 counter surrounded with paraffin to give high efficiency. A fit of the observed angular distributions to a formula $1 + A\cos^2\theta$ gave the result $A(E) = 0{\cdot}15 + 0{\cdot}0027\,E$, where E = bombarding energy in keV. This agrees, within experimental errors, with the anisotropy of proton emission in the competing branch of the *d–d* reaction [Abstr. 2577 (1948)].

A. P. FRENCH

539.172.13

612. The neutrons from the disintegration of the separated isotopes of magnesium by deuterons. C. P. SWANN, C. E. MANDEVILLE AND W. D. WHITEHEAD. *Phys. Rev.*, **79**, 598–600 (*Aug.* 15, 1950).

When Mg^{25} is irradiated by deuterons, 4 groups of neutrons appear from which nuclear energy levels are deduced in Al^{26} at $2{\cdot}00 \pm 0{\cdot}18$ MeV, $3{\cdot}63 \pm 0{\cdot}18$ MeV and $5{\cdot}13 \pm 0{\cdot}18$ MeV. The Q-value for the formation of Al^{26} in the ground state is $5{\cdot}58 \pm 0{\cdot}10$ MeV. From the disintegration data, the mass of Al^{26} is calculated to be $25{\cdot}9935 \pm 9\times10^{-4}$ mu. Bombardment of Mg^{26} by deuterons gives rise to 8 groups of neutrons corresponding to energy levels in Al^{27} at $0{\cdot}88 \pm 0{\cdot}07$, $1{\cdot}92 \pm 0{\cdot}07$, $2{\cdot}75 \pm 0{\cdot}07$, $3{\cdot}65 \pm 0{\cdot}07$, $4{\cdot}33 \pm 0{\cdot}07$, $5{\cdot}32 \pm 0{\cdot}07$ and $5{\cdot}81 \pm 0{\cdot}07$ MeV. The Q-value for the formation of Al^{27} in the ground state is $5{\cdot}68 \pm 0{\cdot}05$ MeV. No quantitative analysis was made of the reaction $Mg^{24}(D,n)Al^{25}$. However, since Mg^{24} was the principal isotopic impurity, it was necessary to show that its presence made no contribution to the spectra of the two preceding reactions. A.

539.172.13

613. Coincidences between protons and gamma-rays in (d,p) reactions. C. D. CURLING AND J. O. NEWTON. *Nature, Lond.*, **166**, 339–40 (*Aug.* 26, 1950).

Scintillation counters to detect protons and γ-rays were placed on opposite sides of a target bombarded with deuterons. The output pulses from the detectors were passed through delay lines of variable length into a coincidence unit of resolving time $0{\cdot}015\,\mu$sec. The (p,γ) coincidence rate was measured as a function of the thickness of absorber between the target and the proton detector. The single counting rate for protons was also recorded. The association of (p,γ) coincidences with all but the longest-range proton groups was established for the Li^6 and B^{10} (d,p) processes. Absorption measurements on the coincident γ-rays indicated that the energies were those expected for direct transitions to the ground states of Li^7 and B^{11} respectively. [See Abstr. 2664 (1950)].

A. P. FRENCH

539.172.13

614. The neutrons from the disintegration of C^{13} by deuterons. C. E. MANDEVILLE AND C. P. SWANN. *Phys. Rev.*, **79**, 787–8 (*Sept.* 1, 1950).

Nuclear energy levels in N^{14} are calculated from Q-values of neutron groups in the reaction $C^{13}(D,n)N^{14}$. Levels occur at $2{\cdot}19 \pm 0{\cdot}07$, $3{\cdot}47 \pm 0{\cdot}07$, $3{\cdot}87 \pm 0{\cdot}07$ and $4{\cdot}90 \pm 0{\cdot}07$ MeV. From a comparison with results of other measurements, it appears that several different nuclear reactions excite the same levels in N^{14}. A.

539.172.13

615. Fast neutrons from the T + D and T + Li reactions. E. ALMQVIST. *Canad. J. Res. A*, **28**, 433–48 (*Aug.*, 1950).

The fast neutrons produced by the triton bombardment of LiF, Li_2CO_3, $LiOH.H_2O$, LiOD and $LiOD.D_2O + D_2O$ have been detected, and the thick target yields and their slowing down lengths in graphite measured. The tritons were produced by irradiating the compounds in the high thermal neutron flux of the thermal column of the NRX pile. The spatial distributions of the fast neutrons from the T + D and T + Li reactions were measured in the graphite with In resonance detectors. The numbers of fast neutrons emitted per second were obtained by comparing the space integrals of the In activity with that measured when a standard Ra-α-Be source of neutrons was in the position of the Li compounds. The number of incident tritons was estimated from the measured flux of thermal neutrons at the Li compound and the total capture cross-section of the Li. The thick target yields were thereby derived. The average cross-sections for neutron production by 2·6 MeV tritons are $1{\cdot}5\times10^{-24}$cm² per atom of Li and $0{\cdot}41\times10^{-24}$cm² per atom of D. The slowing down lengths in graphite of density 1·64g per cc are 19·2 and 23·4 cm for the neutrons from the Li and D respectively. The smallness of the latter indicates that inelastic scattering of these 14 MeV neutrons occurs in graphite. A.

539.172.3

616. Photo-fission of bismuth. N. SUGARMAN. Letter in *Phys. Rev.*, **79**, 532–3 (*Aug.* 1, 1950).

Bismuth samples were irradiated with photons from an 85 MeV betatron, and radiochemical analyses were made for probable fission products. The photo-fission yields are tabulated alongside those obtained with deuteron-induced fission. The photo-fission yield mass curve seems to be narrower than that for deuteron fission, and the primary fission products are probably neutron-excessive. The possibility that the fission might have been induced by secondary fast particles cannot be ruled out. An upper limit of the photo-fission cross-section is given as 10^{-29}cm². T. G. PICKAVANCE

539.172.3

617. Yields of photo-neutrons with calorimetrically measured 320-MeV Bremsstrahlung. D. W. KERST AND G. A. PRICE. Letter in *Phys. Rev.*, **79**, 725–6 (*Aug.* 15, 1950).

539.172.3

618. The photo-disintegration of the deuteron. I. F. E. HANSSON. Letter in *Phys. Rev.*, **79**, 909–10 (*Sept.* 1, 1950).

539.172.4

619. The $B^{10}(n, \alpha)$ Li^7 reaction with fast neutrons and the energy of the reaction $D(d, n)$ He^3. A. STEBLER, H. BICHSEL AND P. HUBER. *Helv. Phys. Acta.*, **23** (*No.* 5) 511–3 (1950) *In German.*

A BF_3 ionization chamber (1 atm. BF_3 + 9 atm. A) surrounded by 1 cm B to remove scattered neutrons of a few eV, was bombarded with (d, d) neutrons and the pulses recorded on a pulse spectrograph. A new resonance level at 2·03 ± 0·04 MeV was found, in addition to that at 1·81 ± 0·04 MeV. The energy of the reaction $D(d, n)$ He^3 is 3·23 ± 0·04 MeV A. O. STANESBY

539.172.4

620. A (n, α) reaction of Fe with slow neutrons. H. HÄNNI AND J. ROSSEL. *Helv. Phys. Acta*, **23** (*No.* 5) 513–16 (1950) *In French.*

100 μ nuclear emulsions (Ilford E_1 and D_1) impregnated with an Fe salt were irradiated with neutrons slowed by 10 cm paraffin. Evidence was obtained for two groups of tracks of length 18 and 24 μ, associated with the thermal neutrons, which are attributed to α-particles, and it is suggested that they are produced in the reactions $^{56}Fe(n, \alpha)^{53}Cr$ or $^{53}Cr^*$. The cross-section is estimated as $4 \pm 2\times10^{-26}$ cm², which is considerably greater than the rough value suggested on semi-theoretical grounds. A. O. STANESBY

539.172.4

621. The energy dependence of the processes $S^{32}(n, p)P^{32}$ and $P^{31}(n, p)Si^{31}$. E. LÜSCHER, R. RICAMO, P. SCHERRER AND W. ZÜNTI. *Helv. Phys. Acta*, **23** (*No.* 5) 561–6 (1950) *In German.*

Resonances observed earlier [Abstr. 1911 (1948)] in the reaction $S^{32}(n, p)P^{32}$ with fast neutrons were confirmed and similar resonances observed also in the reaction $P^{31}(n, p)Si^{31}$, but not in the reaction $Cl^{35}(n, \alpha)P^{32}$. A. O. STANESBY

539.172.4

622. Measurement of uranium fission cross-section with thermal neutrons. U. FACCHINI AND E. GATTI. *Nuovo Cim.*, **7**, 589–605 (*July* 25, 1950) *In Italian.*

The ratio between U fission cross-section and Li cross-section of the $Li^6(n, \alpha)H^3$ reaction for thermal neutrons is determined. The measurement is made exposing a number of Li and U layers to a constant flux of thermal neutrons in an ionization chamber and comparing the number of fission products emitted by U with the number of α- and H^3 particles emitted by Li. The number of U nuclei present in each layer is deduced by counting the number of α-particles emitted by each layer, whilst the number of Li nuclei is found by accurately weighing the Li layers. Assuming the law $\sigma = \sigma_0 v_0/v$ for the fission thermal cross-section of U the ratio $\sigma_u/\sigma_{Li} = 0{\cdot}0596 \pm 2{\cdot}5\%$. Assuming $\sigma_{Li} = 66{\cdot}6 \pm 2\%$ barns, then $\sigma_u = 3{\cdot}97 \pm 0{\cdot}12$ barns, and for the U^{235} $\sigma_u^{235} = 551 \pm 17$ barns. A.

539.172.4

623. Modulation of neutron flux in the reflector of a pile under the effect of absorption and diffusion. V. RAIEVSKI AND J. YVON. *C.R. Acad. Sci., Paris*, **231**, 345–7 (*July* 31, 1950) *In French.*

Dealing with the modulation of neutron flux observed in an ionization chamber, situated in the graphite reflector of a heavy water pile, when a sample is oscillated in a channel through the graphite. The sample is supposed to be a material such as graphite containing boron impurity, in which the effect of scattering may be comparable with the effect of absorption. The fundamental mode of the modulation of the ion chamber current can be represented by the resultant of two vectors $a_+ + b_+x$ and $(c - dx)\exp i\gamma$, where x is the amount of boron in

the graphite. The first vector which is in phase with the mechanical oscillation is a purely local effect in the neighbourhood of the sample, while the second vector represents an overall modulation in the neutron density level of the pile and is retarded in phase (the retardation would be 90° in the absence of delayed neutrons). In the case when $x = c/d$ the oscillation has no effect on the general neutron density level and only the local effect is observed. On the other hand, the local effect is not observed at a large distance from the sample, the quantities a and b depending in a complicated manner on the position of the chamber with respect to the sample.

L. R. SHEPHERD

539.172.4

624. A note on asymmetric fission. T. YASAKI AND O. MIYATAKE. Letter in *Phys. Rev.*, **79**, 740–1 (*Aug.* 15, 1950).

539.172.4

625. The reaction $C^{14}(n, \gamma)C^{15}$. L. YAFFE AND W. H. STEVENS. Letter in *Phys. Rev.*, **79**, 893 (*Sept.*1, 1950).

539.172.4

626. Chemical state of atoms formed from U^{238} in the (n, γ) reaction and in natural α-disintegration. J. GOVAERTS AND P. JORDAN. *Experientia*, **6**, 329–30 (*Sept.* 15, 1950) *In French.*

Expts. were made on U in the form of uranyl salicylaldehyde-o-phenylene-diimine. This complex was dissolved in pyridine and an electric field applied. Atoms of UX_1 resulting from α-decay were almost all collected at the cathode. With slow neutron irradiation the U^{239} produced was electrically neutral but could be chemically separated, probably as UO_3.

A. P. FRENCH

539.172.4

627. Nuclear energy levels in lead isotopes. R. E. PETERSON, R. K. ADAIR AND H. H. BARSCHALL. *Phys. Rev.*, **79**, 935–7 (*Sept.* 15, 1950).

The total neutron cross-section of radiogenic Pb was studied as a function of neutron energy in the range from 15 to 750 keV, using energy resolutions of 3 to 10 keV. Several resonances were observed; these were interpreted as caused by energy levels in the compound nucleus Pb^{207}. The level spacing found in Pb^{207} was of the order of 50 keV. Maxima previously found in the cross-section of ordinary Pb. and attributed to resonance interactions of neutrons with Pb^{208} were re-investigated with better energy resolution. No resonances were observed when earlier measurements of the cross-section of Bi were extended to higher energies. A.

539.172.4

628. Investigation of nuclear energy levels in sulfur. R. E. PETERSON, H. H. BARSCHALL AND C. K. BOCKELMAN. *Phys. Rev.*, **79**, 593–7 (*Aug.* 15, 1950).

The total cross-section of S has been measured for neutrons of energies from 15 to 1 450 keV with energy spreads between 1·5 and 9 keV. Below 750 keV, 9 well-defined maxima are observed, 3 of which are interpreted as caused by *s*-neutrons; the others are believed to be produced by *p*- or *d*-neutrons. The *s*-resonances have natural widths of about 15 keV, while one of the other resonances which was studied in detail has a width of 1·5 keV. In the case of the latter resonance, the compound nucleus appears to be formed with spin of $\frac{3}{2}$. Above 750 keV neutron energy the density of observed levels increases, and no interpretation of the resonances was attempted. A.

539.172.4

629. Production of fast deuterons in the collision of fast nucleons with a nucleus. J. HEIDMANN. *C.R. Acad. Sci., Paris*, **231**, 473–5 (*Aug.* 21, 1950) *In French.*

Heavy nuclei are considered, so that their constituents may be treated statistically. For large energies Born's approximation is applicable. For small energies the momentum wave function of the captured nucleon is the Fermi distribution at 0°K. An approximate value for intermediate energies was calculated, and a complete curve deduced by suitable interpolation. Results at 90 MeV and for large angles are consistent with York's experimental results [*Phys. Rev.*, **75**, 1467 (*May* 1, 1949)]. The total cross-section is found to be 2×10^{-26} cm^2 per nucleon.

L. PINCHERLE

539.172.4 : 518.5 : 621.318.572 : 621.3.012.8

630. Electronic pile simulator. P. R. BELL AND H. A. STRAUS. *Rev. Sci. Instrum.*, **21**, 760–3 (*Aug.*, 1950).

A device which follows the same set of kinetic equations as a chain-reacting pile. The voltage output varies as a function of time as the neutron flux would vary in a pile. A potentiometer varies the effective multiplication factor and can be considered as a control rod. Five delayed neutron periods are simulated. A high precision electronic integrator is used, and the instrument is capable of an accuracy much better than 1%. A.

ATOM AND MOLECULE BEAMS . MESONS . NEUTRONS 539.18

539.18

631. Mesons. C. F. POWELL. *Rep. Phys. Soc., Progr. Phys.*, **13**, 350–424 (1950).

This report deals with discoveries and developments from 1940 to 1950 [for previous reports see Heitler: *Rep. Phys. Soc. Progr. Rep.*, **5**, 361 (1938); Peierls: *Rep. Phys. Soc. Progr. Rep.*, **6**, 78 (1939)]. A brief historical survey is followed by a detailed survey of the properties of the π- and μ-mesons. Evidence for the existence of other types, e.g., neutral mesons, is presented. An important part of the report is a full account of the results obtained with the photographic-emulsion technique. The production of mesons in the atmosphere, as a result of cosmic radiation, is described. L. S. GODDARD

539.18

632. On the nature of the π-meson. B. FERRETTI. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 402 (1949).

The π-meson, assumed to be of spin zero, must be pseudoscalar if it is the nuclear force meson. A method of distinguishing the possibilities that π-mesons are scalar or pseudoscalar is proposed, based on the selection rules of capture by deuterium, in so

far as scalar mesons of energy ~ 10 MeV should be relatively little scattered in deuterium.

J. G. WILSON

539.18

633. On the relative production of π^+- and π^--mesons by neutrons. H. BRADNER, D. J. O'CONNEL AND B. RANKIN. Letter in *Phys. Rev.*, **79**, 720–1 (*Aug.* 15, 1950).

539.18

634. Energies of β-particles from the decay of μ-mesons. J. H. DAVIES, W. O. LOCK AND H. MUIRHEAD. *Nuovo Cim.*, **6** (*Suppl. No.* 3) 346–7 (1949).

The scattering of 81 tracks of decay particles from μ-mesons, of length in Kodak NT4 emulsions greater than 1 000 microns, has been measured, showing the energy distribution of the decay particles (assumed to be electrons) to be continuous, with peak in the region 35–40 MeV.

J. G. WILSON

539.18

635. On the decay of a heavy meson into lighter mesons. S. OZAKI. *Progr. Theor. Phys.*, **5**, 373–94 (*May–June*, 1950).

The probabilities of the following processes have been evaluated using the Pauli regulator: (*a*) $\tau \rightarrow \pi + \gamma$, (*b*) $\tau \rightarrow \pi + \pi_0$, (*c*) $\tau \rightarrow 3\pi$. The limiting values of the lifetimes obtained are: (*a*) $2{\cdot}6\cdot10^{-12}$ to 10^{-15} sec, (*b*) 10^{-14} to 10^{-18} sec; (*c*) 10^{-12} to 10^{-15} sec, the longer time in the latter case corresponding to pseudoscalar coupling.

E. P. GEORGE

539.18

636. The fast protons in π^- meson stars. Y. FUJIMOTO, K. TAKAYANAGI AND Y. YAMAGUCHI. Letter in *Progr. Theor. Phys.*, **5**, 498–500 (*May–June*, 1950).

The capture of π-mesons in nuclei by a process involving 2 nucleons, which remain excited after the capture, is developed, taking into account the momentum distribution of nucleons within the nucleus in the Fermi gas model. This description is shown to be consistent with the observations of fast protons in meson capture stars.

J. G. WILSON

539.18

637. Low energy electrons at the end of μ-meson tracks. W. F. FRY. Letter in *Phys. Rev.*, **79**, 893–4 (*Sept.* 1, 1950).

539.18

638. An unusual π—μ decay track. D. LAL AND H. J. TAYLOR. Letter in *Nature, Lond.*, **166**, 607 (*Oct.* 7, 1950).

539.18

639. An experiment on the anomalous scattering of fast μ-mesons by nucleons. E. AMALDI AND G. FIDECARO. *Nuovo Cim.*, **7**, 535–52 (*July* 25, 1950).

Large-angle scattering of fast μ-mesons by an Fe plate 6 cm thick has been investigated by means of a counter-hodoscope which distinguishes 2 energy bands: from 200 MeV to 320 MeV kinetic energy and from 320 MeV to infinity. About half-a-million impinging mesons have been counted. An upper limit of the cross-section for anomalous scattering is obtained: about $4{\cdot}5\times10^{-29}$ cm²/nucleon in the low-energy band; about $2{\cdot}3\times10^{-30}$ cm²/nucleon in the high-energy band.

A.

539.18

640. On the Coulomb scattering of μ-mesons by light nuclei. E. AMALDI, G. FIDECARO AND F. MARIANI. *Nuovo Cim.*, **7**, 553–74 (*July* 25, 1950).

Using a "one-particle model" of the nucleus, the Coulomb scattering of μ-mesons by light nuclei is treated in Born approximation. One has to distinguish a coherent scattering and an incoherent scattering as in the case of X-rays or slow electrons scattered by atoms. Using a parabolic-well model one can derive, in an elementary way, an expression of the coherent scattering cross-section which is an extension of the well-known Williams formula. Such an expression can be useful in the case of μ-mesons of such a high energy that the corresponding λ turns out to be comparable with the distance of protons inside the nucleus. Also the spectra of the incoherently scattered μ-mesons are derived in an elementary way. Finally the influence on the coherent + incoherent scattering, of a finite value of the electromagnetic radius of the proton, is discussed.

A.

539.18 : 537.531

641. Errata: Meson production by X-ray. Z. KOBA, T. KOTANI AND S. NAKAI. Letter in *Progr. Theor. Phys.*, **5**, 494–5 (*May–June*, 1950).

See Abstr. 7510 (1950).

539.18 : 539.166

642. On the production of γ-rays accompanied by the absorption of π-meson by a proton. S. OGAWA AND E. YAMADA. Letter in *Progr. Theor. Phys.*, **5**, 503–5 (*May–June*, 1950).

The probabilities of absorption of a π^- meson by a proton are estimated in the cases when the process is accompanied by the emission of (i) one photon, (ii) two photons, (iii) a neutral meson π^0. It is assumed that π^- and π^0 are both scalar or pseudoscalar with scalar or ps.-scalar coupling. The shape of the energy spectrum of the photons is given. [R. E. Marshak and A. S. Wightman, Abstr. 510 (1950)].

W. J. SWIATECKI

539.181 : 539.132

643. Energy levels, selection rules, and line intensities for molecular beam electric resonance experiments with diatomic molecules. V. HUGHES AND L. GRABNER. *Phys. Rev.*, **79**, 829–36 (*Sept.* 1, 1950).

Transitions are produced between states with different space quantization of the molecule relative to the electric field and with different couplings of the angular momenta of the nuclei and of the molecular rotation. Thus the interaction of the molecule with the field and the internal molecular interactions (e.g., nuclear electrical quadrupole interactions and nuclear spin/molecular orbit interactions) are measured. In this paper we give the stationary state energy values and eigenfunctions for "very weak," "weak," and "strong" field conditions for a diatomic molecule in which one nucleus has a spin of $\frac{1}{2}$. Selection rules for the transitions are developed and some considerations on line intensities are discussed. Finally, there is presented the theory of double quantum transitions, which are predicted to occur at one-half the frequency given by the Bohr condition,

$\Delta W = h\nu$, provided the radiofrequency field is sufficiently intense. A.

539.185

644. The spin of the neutron. M. Hamermesh and E. Eisner. Letter in *Phys. Rev.*, **79**, 888 (*Sept.* 1, 1950).

539.185

645. Influence of the injection function [of energy] on the distribution of thermal neutrons in a multiplying medium. S. Gallone and C. Salvetti. *Nuovo Cim.*, **7**, 626–37 (*July*, 1950) *In Italian.*

Results obtained in a preceding paper [Abstr. 9015 (1950)] on the thermal neutron distribution function in multiplying media are extended to the case in which the injected neutron energy is higher than the fission neutron energy. Corrections for a non-vanishing mean-free-path of nascent neutrons are taken into account and their influence on the solutions' asymptotical behaviour is discussed. A demonstration of the equivalence between two methods adopted in a previous paper is also given. A.

539.185

646. The Chalk River single crystal neutron spectrometer. D. G. Hurst, A. J. Pressesky and P. R. Tunnicliffe. *Rev. Sci. Instrum.*, **21**, 705–12 (*Aug.*, 1950).

The instrument shows improvement in resolution and intensity over previously described instruments. This has been made possible by the high flux available from the Chalk River heavy water reactor. The instrument can be operated automatically. Mechanical design, crystals, resolution and the contamination of the spectrum by higher orders are discussed. A.

539.185

647. The thermal neutron scattering by ammonium chloride. M. Kimura. Letter in *Phys. Rev.*, **79**, 544 (*Aug.* 1, 1950).

The scattering cross-section for thermal neutrons was measured (by transmission) for NH_4Cl at temperatures from $-70°C$ to room temperature. A maximum was found at the transformation point ($-30°C$) which might arise from the change from order to disorder of the orientation of the (NH_4) ions. J. Thewlis

539.185

648. Neutron-deuteron scattering at 4·5 and 5·5 Mev. E. Wantuch. Letter in *Phys. Rev.*, **79**, 729–30 (*Aug.* 15, 1950).

539.185

649. Upper limit on the cross section for the scattering of neutrinos. J. H. Barrett. Letter in *Phys. Rev.*, **79**, 907–8 (*Sept.* 1, 1950).

539.185.7

650. Neutron cross sections of the elements. R. K. Adair. *Rev. Mod. Phys.*, **22**, 249–89 (*July*, 1950).

A revision of a previous compilation [Abstr. 1915 (1948)]. The cross-section as a function of energy is presented graphically together with a brief general descriptive text. Three curves are given for most elements, covering the low energy region up to ~ 1 keV, the medium energy region from 15 keV, to a few MeV, and the high energy region from one or two MeV to 300 MeV. J. Hughes

539.185.7

651. Neutron cross sections at 120 and 345 Ev. C. T. Hibdon. *Phys. Rev.*, **79**, 747–9 (*Sept.* 1, 1950).

Total neutron cross-sections of 19 elements have been measured at 120 and 345 eV by employing the neutron resonance scattering properties of Co and Mn. Thin foils of Co and Mn were used as neutron detectors at 120 and 345 eV, respectively. A semi-logarithmic plot of neutron counts *v.* thickness of sample was made for each element for each of the two energies. An initial curvature in the plot indicated that the detector resonance overlapped a resonance in the element under study. The cross-section determined from either a straight-line plot or the asymptotic part of a transmission curve was identified as either the potential scattering cross-section, the off-resonance scattering cross-section, or as the minimum cross-section in the neighbourhood of a resonance. A.

539.185.7

652. Pile neutron absorption cross sections of some of the elements. F. C. W. Colmer and D. J. Littler. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1175–6 (*Oct.*, 1950).

STRUCTURE OF SOLIDS 539.2

539.211 : 541.64

653. On crazing of linear high polymers. C. C. Hsiao and J. A. Sauer. *J. Appl. Phys.*, **21**, 1071–83 (*Nov.*, 1950).

The effect of various variables, such as type of stress, stress magnitude, duration of stressing, and environment on the initiation and development of crazing is discussed. The basic nature of crazing is investigated in some detail for polystyrene specimens by means of the light microscope, the electron microscope and the X-ray spectrometer. The results of these observations and their bearing on the fundamental group structure of polystyrene molecules is presented. The relationship between crazing and orientation is discussed, as well as the effect of both of these factors on the mechanical properties. The experimental results are compared, wherever possible, with the previously reported data of other investigators. A short discussion is then given of a theory of crazing from the point of view of the molecular structure of the material. A.

539.211 : 548.55

Single crystal copper surfaces. *See Abstr.* 746

539.215.4

654. The "Conifuge"—A size-separating sampling device for airborne particles. K. F. Sawyer and W. H. Walton. *J. Sci. Instrum.*, **27**, 272–6 (*Oct.*, 1950).

Consists basically of a conical self-pumping centrifuge, in which the indrawn cloud is "winnowed" by an internally circulating stream of clean air in such a way that the particles are classified according to their settling velocities and deposited on a glass slide in a continuously graded sample. When the particles are of similar shape and density, the settling velocities are a unique function of the size, and the deposit is in the form of a spectrum of particle sizes with a high

degree of purity. For spherical particles of unit density, the spectrum extends from about 30 to 0·5 μ diameter. The sampling rate is 25 cc/min. A.

539.215.6

655. Note on "Interference of growing spherical precipitate particles." H. MARKOVITZ. Letter in *J. Appl. Phys.*, **21**, 1198 (*Nov.*, 1950).

See Abstr. 2705 (1950).

539.217

656. Diffusion coefficient of C in α-iron. C. A. WERT. *Phys. Rev.*, **79**, 601–5 (*Aug.* 15, 1950).

An equation of the form $D = D_0 e^{-\Delta H/RT}$ is developed for interstitial diffusion in cubic lattices. This development uses a classical statistical mechanical treatment. Measurements of D for C in α-iron were made from — 35° to 200°C. Combined with earlier data they extend the knowledge of D in this system from $D = 10^{-20}$ to $D = 10^{-6}$ cm²/sec. The values of D_0 and ΔH obtained by fitting the above equation to the experimental points give $D_0 = 0{\cdot}02$ cm²/sec and $\Delta H = 20\,100$ cal./mole. A.

539.217

657. Diffusion of lead chloride dissolved in solid silver chloride. C. WAGNER. *J. Chem. Phys.*, **18**, 1227–30 (*Sept.*, 1950).

A particular solution of the differential equation of diffusion involving a diffusion coefficient proportional to concentration is presented. From previous experiments by Wagner and Zimens the diffusion coeff. for the exchange of Pb and Ag ions, extrapolated to the concentration of a saturated solution of $PbCl_2$ in solid AgCl, is calculated to be $2{\cdot}4 \cdot 10^{-9}$ cm²/sec at 270°c. Therefrom it follows that the self-diffusion coeff. of Pb ions equals $0{\cdot}8 \cdot 10^{-9}$ cm²/sec. In contrast, the self-diffusion coeff. of Ag ions, derived from conductivity measurements of Koch and Wagner, amounts to $9{\cdot}2 \cdot 10^{-8}$ cm²/sec. A.

539.217

658. Self-diffusion of sodium in sodium chloride and sodium bromide. D. MAPOTHER, H. N. CROOKS AND R. MAURER. *J. Chem. Phys.*, **18**, 1231–6 (*Sept.*, 1950).

The self-diffusion coeff. of Na in NaCl and NaBr has been measured as a function of temperature. A comparison of the self-diffusion coeff. with the electrolytic conductivity reveals that the Einstein relation is satisfied at high but not at low temperatures. The temperature dependence of the diffusion coeff. may be explained by the Schottky–Wagner vacancy theory if the presence of impurity ions is taken into account. A possible explanation for the failure of the Einstein relation in terms of association between multivalent foreign ions and vacancies is suggested. A.

539.217

659. The diffusion rates of some metals in copper, silver, and gold. O. KUBASCHEWSKI. *Trans Faraday Soc.*, **46**, 713–22 (*Sept.*, 1950).

The diffusion rates of Zn, Cd and Ag in Cu (at temperatures between 710° and 860°c) and of Ag in Au (800° to 1 000°c) have been determined by a method which permitted the application of Stefan and Kawalki's tables. Analyses were carried out by a spectrographic method. These alloys containing Zn and Cd, which have relatively high vapour pressures at the temperatures of experiment, were tightly enclosed in thick-walled iron cylinders in order to avoid effects due to evaporation of metal. The literature concerning the diffusion rates of Ni, Pd, Pt, Cu, Ag, Au, Zn and Cd in Cu, Ag and Au is reviewed, and the most probable constants of Arrhenius' equation for each system are derived from this survey. The low estimated accuracy of these figures reveals that most of the data require careful re-determination. A.

539.217

660. Frequency factor and activation energy for the volume diffusion of metals. G. J. DIENES. *J. Appl. Phys.*, **21**, 1189–92 (*Nov.*, 1950).

The theoretical equations proposed for calculating D_0 of the diffusion-constant-temperature relation $D = D_0 e^{-E/RT}$ are critically discussed in the light of presently available data. It is concluded that none of the relations gives satisfactory agreement with experiment. Empirical analysis of experimental data covering a wide range of D_0 and E values showed that the quantity E/T_m, where T_m is the melting point in °K, is the main factor in determining the value of D_0, and that D_0 depends approximately exponentially on E/T_m. In addition to many other diffusion constants it is shown that the anisotropic diffusion of Zn and the widely differing diffusion constants for self-diffusion in α- and γ-iron are included in the proposed empirical correlation. A possible theoretical basis for the empirical correlation is described based on the idea of local melting or disordering. The quantity E/T_m is identified with the entropy of activation. A.

539.218

661. Notes on the deposition of sand. J. KOLBUSZEWSKI. *Research, Lond.*, **3**, 478–83 (*Oct.*, 1950).

A study of the factors on which the porosity of a sand deposit depends. The porosity is high when either the rate of deposition is high or the velocity of deposition low and the author concludes that to get a tightly packed deposit it is necessary for the particles to have sufficient energy to rearrange themselves and also sufficient time for this to occur before rearrangement is inhibited by the arrival of other grains.

J. M. HOUGH

539.234

662. Evaporation of thin uniform layers of controlled thickness. Electronic applications. C. DUFOUR. *Vide*, **5**, 837–44 (*July–Sept.*, 1950) *In French.*

A method is described yielding uniform layers by means of evaporation in a vacuum. The accuracy is about 1% and the area treated 20 cm diameter. During the process of evaporation the thickness of the layer can be controlled to 0·02 μ approx. These conditions are essential in CRT for radar and television. A turn-table moves in a rotating electric field which is generated outside the vacuum chamber (induction motor) within which the table rotates. On top of crucibles of 0·5 cm³ capacity a fine meshed grille is kept at a temperature slightly above that of the crucible. Mo crucibles take up to 200 A heater current. Materials transparent to light show for a change in thickness of 3 μ a change in colour of 60 Å width that can easily be observed visually between approx. 5 000 and 6 000 Å. The green Hg line 5 461 Å is a convenient wavelength. By arranging

a number of crucibles each containing a different material it is possible to produce a variety of superimposed layers. All results are reproducible and can be attained with relative ease. W. SUMMER

539.27

663. Graticules as guides in electron-microscope metallography. E. DE HAAS. Letter in *Nature, Lond.*, **166,** 482–3 (*Sept.* 16, 1950).

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.31 : 539.53

664. Crystalline interaction and the hardness of metals. P. LAURENT AND M. EUDIER. *Rev. Métall.*, **47,** 582–8 (*Aug.*, 1950) *In French.*

The effect of crystal grains in producing anisotropic elastic properties in metals is discussed theoretically. Relations between various elastic moduli are derived, in good agreement with experiment. The problems of hardness are briefly considered. E. P. WOHLFARTH

539.313

665. A contribution to the study of the form of the stress-strain curves of metals and its physical interpretation. C. CRUSSARD AND B. JAOUL. *Rev. Métall.*, **47,** 589–600 (*Aug.*, 1950) *In French.*

Using a Chevenard microtester, a study has been made of the curves of Al (principally), Cu, Zn and Mg. Results have been interpreted in terms of the equation $\sigma = \sigma_0 + A\varepsilon^m$ (σ = stress, ε = strain, σ_0, A and m being constants). A suitable log-log plot reveals the existence of two stages, each satisfied by an equation of this form, but with different constants. A wide investigation has been made of the variation of these constants with certain factors: grain-size, diameter of the wire (for same grain-size), speed of extension, etc. In the region of the first parabola, e.g., the curves of m or A as a function of grain-size (N grains/mm^2) were similar, and for all N, $A = 100\,m - 35$ (in kg/mm^2). For large grains, m-values vary largely with diameter, but converge as N increases. The point of transition to the 2nd parabola is almost independent of N, or the speed of test, and of the diameter and is taken to be characteristic of the metal. It is associated with a process of polygonization in the grains. The influences of impurities, and of temperature, are discussed. The results are interpreted in terms of dislocation concepts with particular reference to the mechanism proposed by Cottrell. A. J. KENNEDY

539.313

666. Stress-strain properties of natural rubber under biaxial strain. B. B. S. T. BOONSTRA. *J. Appl. Phys.*, **21,** 1098–104 (*Nov.*, 1950).

Tube-shaped samples were stretched in a direction parallel to the tube axis and at the same time inflated to cause a tangential extension. In this way 600% axial and 300% tangential elongation could be attained simultaneously. The stresses were calculated from the pressure in the tube and the dynamometer readings. The results are plotted as axial stress-strain curves at different tangential elongations ranging from 0–300%. The curve for a higher tangential elongation lies at higher stresses than that for a lower tangential elongation; the differences are, however, larger than the theory predicts. At 600% axial elongation stress relaxation was measured at different tangential elongations. It appears that the relaxation constant is independent of the tangential elongation. A.

539.319 : 535.417

667. Determination of residual stresses of quenching origin in solid and concentric hollow cylinders from interferometric observations. A. W. SÁENZ. *J. Appl. Phys.*, **21,** 962–5 (*Oct.*, 1950).

The method relies on interferometric data and assumptions whose validity for the technically important case of glass is supported by a number of experimental investigations. The results should be of interest for the analysis of stresses in quenched glass cylinders, so great in magnitude that the usual cutting techniques are precluded, because of the explosive characteristics of highly stressed objects of this material. A.

539.32 : 534.321.9

668. A new method of measuring the elastic constants of solids. K. VEDAM. Letter in *Curr. Sci.*, **19,** 205–6 (*July*, 1950).

A piece of piezo-electric quartz is attached to the material to be investigated and the variation of ultrasonic energy transmitted through the material with the frequency is studied over the entire resonance band of the transmitting quartz. The specimen is more than 1 cm thick, giving a fundamental frequency of 100–200 kc/s, and the energy transmitted through it exhibits a series of maxima which are studied by the Debye–Sears and Lucas–Biquard technique. The difference between successive maxima corresponds to the longitudinal fundamental frequency of the specimen, from which the elastic constant in that direction can be determined. The method has been applied to tests of optical glasses and the results agreed well with those obtained by Hiedemann's method. A. C. WHIFFIN

539.32 : 535.55

669. Elastic and photoelastic properties of some optical glasses. K. VEDAM. *Proc. Indian Acad. Sci. A*, **31,** 450–8 (*June*, 1950).

The elastic and photo-elastic constants for a set of 18 optical glasses of widely varying composition have been measured. The elastic constants and the quantities p_{11}, p_{12}, q_{11} and q_{12} have in general no correlation with the density or the refractive index. However, when glasses of similar composition are compared, the photo-elastic constants are found to increase, as the Pb content in the glass increases; also the value of p/q is found to diminish progressively thus confirming Pockels' observations. A.

539.32 : 548.0

670. Determination of elastic constants in single crystals with especial reference to silver chloride. D. L. ARENBERG. Letter in *J. Appl. Phys.*, **21,** 941–2 (*Sept.*, 1950).

Two single crystals of AgCl were cut with reference to their axes and then ground. After annealing, the crystals were developed to produce a Ag electrode on the surfaces, and the ultrasonic pulse technique was used to measure the velocity of sound at 15 Mc/s in

the different crystal directions, from which the elastic constants were determined. Corrections were applied to account for the thickness of the piezo-electric transducers. When a pure mode generator operates at normal incidence on the crystal, mode transfer occurs at each reflection resulting in a complex system of echoes which has to be analysed into the 3 different fundamental modes. Changing the orientation of a shear-wave transducer on the specimen can only affect the amplitudes of the echoes, and, with care, only one period between echoes will be observed; the analysis is greatly simplified, leading to reliable values for the elastic constants in the principal directions. A. C. WHIFFIN

539.32 : 548.0

671. Elastic constants of the heptahydrates of magnesium and zinc sulphates. R. V. G. SUNDARA RAO. *Proc. Indian Acad. Sci. A*, **31**, 365–70 (*June*, 1950).

The elastic constants of the orthorhombic crystals, Mg and Zn sulphate heptahydrates have been determined by the ultrasonic method. The elastic moduli and the compressibilities for the same are also calculated. A.

539.32 : 666.98

672. New method of measuring the modulus of elasticity and the possibility of using it on concrete. A. MARGARIT. *Rev. Cienc. Apl.*, **4**, 333–42 (*July–Aug.*, 1950) *In Spanish.*

An oscillatory system is employed to transmit energy to a similar system via a specimen of the material under test, and a theoretical study of the problem shows that the method can be used to determine the modulus of elasticity of the material. The technique has been applied to determine the variation of the modulus of concrete with age, but no results are given. Oscillograms illustrate the movements of the various parts of the system.

A. C. WHIFFIN

539.373

673. Multiplication processes for slow moving dislocations. F. C. FRANK AND W. T. READ, JR. Letter in *Phys. Rev.*, **79**, 722–3 (*Aug.* 15, 1950).

Purely topological reasoning can explain how a very large amount of slip can result from the motion of a single dislocation line, and the quantitative treatment is similar to the theory of crystal growth, allowance being made for mutual repulsion between turns. Another process occurs when a part of a dislocation lies in one glide plane (the remainder lying outside the plane), and this is discussed for the case where the "end-points" may be considered fixed. A. J. KENNEDY

539.374

674. A contribution to the study of the plastic deformation of metals by extension and by drawing. J. NAVARRO. *Rev. Métall.*, **47**, 601–13 (*Aug.*, 1950) *In French.*

A variety of experimental results, principally with wires of electrolytic Cu (confirmed to some extent with certain other metals) on the change of mechanical properties, e.g. yield point and rupture stress, with change in the preparation conditions, e.g. angle of die and speed of drawing. Results are stated without theoretical interpretation or correlation. In general, they re-emphasize the wide dependence of the state of the metal on previous history. A. J. KENNEDY

539.374

675. An optical method for studying the deformation of mild steel. E. O. HALL. Letter in *Proc. Phys. Soc., Lond.*, **63**, 724–6 (*Sept.*, 1950).

The technique enables the development of the "secondary" Lüders' band to be followed. A previous technique was used to obtain small spheres of Sn which are mounted half way down the tensile wire specimen, forming, when illuminated, a vertical row of secondary sources which is focused on photographic paper on a drum camera. A record is reproduced showing how the rate of advance of the band edge, and the Lüders' strain, may be determined. One result of the investigation is to show that if the grain size is above a critical value (60 ± 3 grains/mm for a certain steel containing 0·045%C) no amount of straining or ageing will induce a Lüders' band to appear. A. J. KENNEDY

539.374

676. The flow and fracture of a brittle material. L. F. COFFIN, JR. *J. Appl. Mech.*, **17**, 233–48 (*Sept.*, 1950).

The mechanism of flow and fracture of a grey cast iron can be understood if one considers the microstructure to consist of a ductile structure with a random dispersion of cracks due to the graphite flakes following the concept of Fisher. A notch effective stress can be calculated for a critically situated crack by a knowledge of the external stresses, a plastic stress-concentration factor of 3, and a residual tensile stress at the sharp edge of the crack, based upon either the "maximum-shear" theory or the "distortion-energy" theory. This allows the formulation of generalized plastic stress-strain relationships and renders grey cast iron applicable to the many known solutions for plastic flow of ductile metals. Fracture in the region of tension-tension and tension-compression can be evaluated by a similar analysis, using the same stress-concentration factor and the same residual stress. A.

539.374

677. Approximate solutions of problems of plane plastic flow. P. G. HODGE, JR. *J. Appl. Mech.*, **17**, 257–68 (*Sept.*, 1950).

A method of approximating the stress and velocity fields in problems of plane plastic flow is presented. A general procedure for finding the deformed pattern of an originally square grid is devised and applied to two examples. The results are compared with known continuous solutions and with experiments. A.

539.374

678. Residual strains in plastically deformed mild steels. L. G. FINCH; G. B. GREENOUGH. *Nature, Lond.*, **166**, 508–10 (*Sept.* 23, 1950).

Back-reflection X-ray measurements on plastically deformed low-C steels indicated that after yielding there was present an inconsistent body strain with superimposed Heyn strains, and that all lattice planes tended towards residual contraction as necking proceeded. An explanation of these effects is suggested. Previously published results [Abstr. 3692

(1947)] on residual lattice strains are corrected for errors due to small amounts of alloying elements and are now in agreement with the suggested interpretation of the Heyn stresses. There remains, however, a superimposed compressive microscopic stress. The mechanism of plastic deformation is discussed briefly.

A. E. De BARR

539.374

679. Plasticity of wool. O. Ripa and J. B. Speakman. Letter in *Nature, Lond.*, **166,** 570–1 (*Sept.* 23, 1950).

539.374

680. The propagation of plastic deformation in solids. T. von Karman and P. Duwez. *J. Appl. Phys.*, **21,** 987–94 (*Oct.*, 1950).

The stress wave caused by a longitudinal impact at the end of a cylindrical bar has been analysed in the case where the impact velocity is large enough to produce plastic strain. The theory gives a method for computing the stress distribution along the bar at any instant during impact. It is shown that for a given material, there is a critical impact velocity such that when subjected to a tension impact with a velocity higher than the critical, the material should break near the impacted end with negligible plastic strain. An experimental investigation was made concurrently with the theoretical study. Some of the most significant results are presented. A.

539.374

681. Effective stress and effective strain in relation to stress theories of plasticity. G. N. White, Jr., and D. C. Drucker. *J. Appl. Phys.*, **21,** 1013–21 (*Oct.*, 1950).

The correlation of experimental data and the proper description of the state and history of deformation of work-hardening materials has received much attention. An often desired objective is the plotting of a variable involving stress alone, a so-called effective stress, against a variable depending on the instantaneous strain or the history of strain, effective strain. Quantities such as maximum or octahedral shearing stress and strain or, better, an integrated effective strain increment have been employed. Also, simple effective stress definitions have been given for anisotropic as well as isotropic metals by Dorn, by Jackson, Smith, Lankford, and by previous investigators. It is shown that the stress-strain relations of a recent theory of plasticity provide a very convenient means of defining and studying effective stress and effective strain. The strong theoretical and practical limitations of such concepts are indicated and the calculation of specific plastic work is discussed for both isotropic and anisotropic metals. A.

539.4

682. A remark about standardization and "A dimensional analysis of metal cutting." A. Martinot-Lagarde. Letter in *J. Appl. Phys.*, **21,** 1197 (*Nov.*, 1950).

See Abstr. 2734 (1950).

539.4.019.1

683. The application of rate-process theory to glass. I. Breaking strength. F. B. Hodgdon, D. A. Stuart and F. E. Bjorklund. *J. Appl. Phys.*, **21,** 1156–9 (*Nov.*, 1950).

An equation relating the ultimate strength of glass and porcelain to time under load is derived using the rate-process theory of Eyring. The data of Preston and co-workers are used to calculate the constants in the equation. The agreement between theoretical and experimental results is excellent. A.

539.4.019.1

684. The application of rate-process theory to glass. II. Viscosity. F. B. Hodgdon and D. A. Stuart. *J. Appl. Phys.*, **21,** 1160–70 (*Nov.*, 1950).

In previous efforts to derive an equation for the temperature-viscosity relation of glass it has been assumed, tacitly or otherwise, that glass is a simple liquid. Since glass is not a simple liquid, it is necessary to find a model that will, in its reaction to applied stresses, have the same characteristics as a specimen of glass. By the use of Eyring's rate-process theory, such a model is proposed and several equations relating viscosity to time and to temperature are derived. The equations include an equation that relates the viscosity of any glass specimen to time, one which defines the rate of removal of internal strain, and an equation which relates the viscosity of a specimen an infinite time after beginning of a test to the temperature of the test. This final viscosity is the viscosity usually reported in the literature. It is found that the parameters in the equation reduced to infinite time can be calculated from the chemical composition of the glass and the viscosity of any given glass can be predicted at any temperature over a very wide range. Curves and tables are included to show the agreement of experiment and theoretical values. A.

539.4.019.1 : 666.1/.2

685. Erratum: The mechanical properties of glass. F. W. Preston. *J. Appl. Phys.*, **21,** 1195 (*Nov.*, 1950).

See Abstr. 752 (1943).

539.412.1

686. Tearline patterns in ferrochromium. C. A. Zapffe and F. K. Landgraf. Letter in *J. Appl. Phys.*, **21,** 1197–8 (*Nov.*, 1950).

539.43

687. On the endurance limit of a round bar with longitudinal grooves. H. Okubo. *J. Appl. Phys.*, **21,** 1105–8 (*Nov.*, 1950).

It was considered, in a previous paper, that the endurance limit of a material should be determined by the amount of the mean stress in a certain area around a point, instead of the stress at the point, and the extent of the area is determined for several kind of metals, by using the results of tension-compression fatigue tests. The extent of area where the mean value of stress to be taken has now been determined for a mild steel in another way, viz. by a torsion fatigue test, and the conclusion reached that the extent of area chiefly depends on the kind of metal and is independent of the course of the experiment. A.

539.434

688. Creep deformation of metals. L. Rotherham and L. W. Larke. Letter in *Research, Lond.*, **3,** 434–6 (*Sept.*, 1950).

Observations on Al 0·5% Ag alloy indicate that in a number of cases grain growth had no effect on creep rate. It is suggested that the breakdown to sub-grains which is also observed is a secondary effect resulting from creep. A. E. De BARR

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.3 : 542.48

689. On a distillation theorem by Schreinemakers. O. REDLICH AND A. T. KISTER. *J. Chem. Phys.*, **18**, 1108–9 (*Aug.*, 1950).

According to a theorem of Schreinemakers the distillation lines giving the composition of the contents of the distilling vessel when distillation takes place without reflux are, at their end-points, tangential to the boundary lines of the phase-rule triangle for a ternary system. This would lead to the practical conclusion that of two impurities one would always be much more easily removed than the other. It is shown mathematically that the distillation lines cannot, in fact, be tangential to the boundary lines. Similar considerations apply to azeotropic points as to boundary points. A. J. MEE

541.126

690. A study of sensitized explosions. VIII. Experimental work on the hydrogen-oxygen reaction sensitized by chloropicrin. P. G. ASHMORE AND R. G. W. NORRISH. *Proc. Roy. Soc. A.*, **202**, 454–71 (*Oct.* 24, 1950).—For previous parts see Abstr. 828 (1941).

541.126

691. A study of sensitized explosions. IX. Experimental work on the sensitization of ignitions of hydrogen-chlorine mixtures by chloropicrin. P. G. ASHMORE AND R. G. W. NORRISH. *Proc. Roy. Soc. A.*, **203**, 472–86 (*Sept.* 22, 1950).

541.127

692. Arrhenius parameters and chemical reactivity. S. V. ANANTAKRISHNAN. *Proc. Indian Acad. Sci., A*, **32**, 52–63 (*July*, 1950).

Experimental data on different reactions commonly used in the study of organic compounds have been studied and the parameters of the reaction rate equation considered in relation to mechanism and the structure of the compounds. The limitations of these reactions and the relation of reactivity to the Arrhenius parameters is also brought out. A.

ELECTROCHEMISTRY 541.13

541.13.082

693. An automatic recording polarograph. T. J. SPROTT. *N.Z. J. Sci. Techn.*, **30**, 269–73 (*March*, 1949).

The instrument described does not involve photography, the current-voltage curve being traced in ink on ordinary graph paper. A.

541.135

694. The electroplating of metallic selenium. A. VON HIPPEL AND M. C. BLOOM. *J. Chem. Phys.*, **18**, 1243–51 (*Sept.*, 1950).

The electroplating of metallic Se from acid baths has been achieved and reduced to practice. The paper discusses in succession the polymorphism of Se; Se ions in selenious acid solution; cathodic deposition as the amorphous and metallic phase; the nucleation characteristic and crystal growth of the metallic modification; the properties of various types of plating baths; a Se–C anode for the stabilization of the bath composition; and finally a number of influences affecting the crystallization habit of the deposit. The current density of 200 amp/ft² attainable in a well-balanced plating bath compares favourably with standard baths for true metals. A.

541.135 : 537.311.32 : 548.0

On the theory of ionic conductivity in crystals. *See Abstr.* 735

541.135.1

695. Studies on the surface areas of cadmium and copper, and the mechanism of cadmium polarization. J. M. ROXBURGH AND C. A. WINKLER. *Canad. J. Res. B.*, **28**, 383–90 (*July*, 1950).

The areas of mechanically cleaned Cd electrodes measured by rate of build-up of H overvoltage have been shown to decrease with time of immersion in air-free acid solutions. The relative rate of decrease did not depend upon acid concentration in excess of 10^{-2} molar, nor upon passage of current or initial area, but exposure to air accelerated the decrease in area. The measured area was shown to depend upon the current used for the measurement, particularly with electrodes of large areas. Cu electrodes did not show the effects observed with Cd. Cd polarization was shown to be linearly related to current, and independent of the measured area. This indicates that concentration polarization is operative in the deposition of Cd. A.

541.135.1

696. The effect of ionic strength on polarographic half-wave potentials. D. D. DEFORD AND D. L. ANDERSEN. *J. Amer. Chem. Soc.*, **72**, 3918–20 (*Sept.* 1950).

The half-wave potential of Cd has been studied as a function of ionic strength in supporting electrolytes of HNO_3 and of NH_4, Li, Ca, Mg and Al nitrates for a range of ionic strengths extending up to 12 *M*. The half-wave potential varies as the ionic strength and the character of the ionic environment are altered. Factors responsible for changes which occur as a result of changes in the composition of the solution are discussed. The necessity of considering the effects of ionic strength and ionic environment in the polarographic investigation of complex-formation is emphasized. A.

541.135.1

697. Electrokinetics of hydrogen evolution. I. Hydrogen overvoltage on mercury. B. POST AND C. F. HISKEY. *J. Amer. Chem. Soc.*, **72**, 4203–8 (*Sept.*, 1950).

Measurements of overvoltage have been made at current densities from 10^{-1} to 10^{-3} amp/cm² and at temperatures from 0·0 to 91·3°. Reproducibility of measurements for individual runs is ± 2 mV; for separate runs, in different cells, reproducibility is ± 5 mV. The average of a series of determinations of ΔH was found to be 21·6 kcal g ion^{-1}; the average deviation of individual determinations from this

mean is 0·2 kcal. This compares with values of 20·7 to 21·6 kcal g ion^{-1} computed from Jofa and Mikulin's data and with 18·0 kcal, reported by Bowden. A.

541.135.64

698. A theory of depolarization in manganese dioxide cells. J. Brenet. *C.R. Acad. Sci., Paris*, **231**, 543–5 (*Sept.* 11, 1950) *In French.*

Calculation of the density of pyrolusites by two different methods has led to a theory of depolarization in MnO_2 cells which is of a purely physical character as opposed to the chemical viewpoint extant. This theory visualizes a dislocated state of the MnO_2 in the sense conceived by Mott [*Research*, **2**, 162 (1942)], and enables very satisfactory agreement between the actual amount of electricity afforded by such cells and the calculated values based on the theory. H. H. HODGSON

541.136 : 536.7

699. The correct application of the Gibbs–Helmholtz equation to reversible galvanic cells in which several phases are in equilibrium at one of the electrodes. R. E. Barieau. *J. Amer. Chem. Soc.*, **72**, 4023–6 (*Sept.*, 1950).

It is pointed out that confusion over the application of the Gibbs–Helmholtz equation has resulted from a failure to write correct cell reactions for cells involving several phases in equilibrium at the electrodes. The principle to be followed in writing the correct cell reaction for such cells is stated, and its application is demonstrated by developing the complete cell reaction for the Clark cell. Correct cell reactions are written for cells containing two phase amalgams at one of the electrodes. A.

541.136.1

700. Studies on galvanic couples. I. Measurement of electromotive force and internal resistance of cells during current flow. H. D. Holler. *J. Electrochem. Soc.*, **97**, 271–6 (*Sept.*, 1950).

A method of measuring the effective electromotive force and internal resistance of a galvanic cell during current flow is described. A dry cell was used for demonstration of the method. By introducing a reference electrode into a cell consisting of an Fe electrode and a magnetite electrode in wet clay, it was possible to measure the potential and resistance between the reference electrode and either the Fe or magnetite during current flow. When the Fe and magnetite were short-circuited, the potential and resistance between the reference electrode and the Fe-magnetite couple were measured. By impressing current upon the galvanic couple from an auxiliary electrode, the potential-current characteristic of the couple was determined. It was shown that an Fe plate in wet clay exhibits such a characteristic similar to that of the galvanic couple. A.

541.138.2

701. Studies on galvanic couples. II. Some potential-current relations in galvanic corrosion. H. D. Holler. *J. Electrochem. Soc.*, **97**, 277–82 (*Sept.*, 1950).

A graphic method of expressing the electrical characteristics of a galvanic couple was developed by the application of Kirchhoff's laws to a couple consisting of separate electrodes, each with an ammeter in series. When an external e.m.f. was impressed between the couple and a 3rd electrode, also with an ammeter in series, a definite current pattern was established, depending on the relative directions and magnitudes of the impressed e.m.f. and the potential of the couple. These relations were demonstrated with the Fe-magnetite couple. Under the conditions used, a discontinuity in the potential-current relation was observed, when the couple was cathodically polarized over a sufficient range of current. This discontinuity or "break" coincided with reduction of current, circulating within the couple, to zero. The rise in potential at this point is the logical result to be expected from the H overvoltage. A.

541.138.2 : 538.12

702. Use of a magnetic field in detecting corrosion currents. F. Blaha. Letter in *Nature, Lond.*, **166**, 607 (*Oct.* 7, 1950).

541.138.2 : 539.219

703. Corrosion rate and etch structures of aluminium; effect of heat treatment and impurities. B. Roald and M. A. Streicher. *J. Electrochem. Soc.*, **97**, 283–9 (*Sept.*, 1950).

541.138.2 : 541.127.1

704. The rate of corrosion of silver in solutions of ferric sulfate. H. Salzberg and C. V. King. *J. Electrochem. Soc.*, **97**, 290–7 (*Sept.*, 1950).

Metals down to Cu in the e.m.f. series dissolve in ferric salt solutions at maximum diffusion controlled rates, with quantitative reduction of ferric to ferrous ion. Ag, however, reaches an equilibrium with only partial reduction of ferric ion, and the dissolution rate is smaller than with more active metals. This paper reports a study of the corrosion or dissolution rate of Ag in ferric salt solutions as a function of (*a*) the concentration of the ions involved, (*b*) the concentration of the acid, (*c*) speed of stirring, (*d*) temperature, and (*e*) e.m.f. of the Ag–Ag ion, ferric-ferrous ion cell. The rate has been found to be greatly influenced by adsorption of ions formed in the reaction. A rate equation has been derived which includes the effects of adsorption and of the reverse reaction. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14

541.14

705. The mercury ($^3P_1$) photosensitized reaction of atomic hydrogen with methyl chloride. G. L. Lee and D. J. Le Roy. *Canad. J. Res. B*, **28**, 500–6 (*Aug.*, 1950).

The method of Hg photosensitization has been used in an investigation of the reaction between atomic H and CH_3Cl at 25°c. The main products are CH_4, HCl and CH_2Cl. The last is assumed to rise through recombination of chloromethyl radicals formed by either of the reactions, $H + CH_3Cl = CH_2Cl + H_2$ or $Hg(^3P_1) + CH_3Cl = CH_2Cl + H + Hg(^1S_0)$. A.

541.14 : 537.531

706. X-ray dose determinations with chloral hydrate. H. L. Andrews and P. A. Shore. *J. Chem. Phys.*, **18**, 1165–8 (*Sept.*, 1950).

The chemical effects of X-rays on aqueous solutions

of $CCl_3CH(OH)_2$ have been studied. The primary reaction is the conversion of the organic halogen to HCl and the resulting changes in electrical conductance have been used for the determination of X-ray dosage. The change in conductance is linear with X-ray dose and independent of dose-rate over a wide range. This compound has been used to determine the total output and depth-dose curves from a high intensity Be window X-ray tube. A.

541.144.7 : 541.64

707. The non-stationary phase of chain reactions. I. The photopolymerization of styrene. G. M. Burnett. *Trans Faraday Soc.*, **46,** 772–82 (*Sept.*, 1950).

By means of an adaptation of the dilatometer of Schulz and Harborth, in order to operate *in vacuo*, and with a great increase in sensitivity it has been found possible to demonstrate the existence of a natural induction period in the photopolymerization of styrene. The method has been applied to the determination of the kinetic constants for styrene polymerization, the values obtained being in good agreement with those quoted in the literature. A.

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.18

708. Lord Kelvin's contributions to surface chemistry. (The 41st Kelvin lecture.) E. K. Rideal. *Proc. Instn Elect. Engrs, Pt I,* **97,** 273–8 (*Nov.*, 1950).

Topics such as the free energy of surfaces, the vapour pressure over curved surfaces and porosity, and surface potentials are considered. R. F. BARROW

541.18 : 535.434 : 535.33.07

709. Light scattering and spectrophotometry of colloidal solutions. P. Doty and R. F. Steiner. *J. Chem. Phys.*, **18,** 1211–20 (*Sept.*, 1950).

During the past several years it has been demonstrated that the light scattered from dilute solutions of macromolecules or colloidal particles is intimately related to the weight, size and interaction of the solute species, and it would appear that the equivalent information concerning macromolecules could be derived from a different means of observation—that of transmission measurements at various wavelengths. If this possibility could be exploited the common techniques of spectrophotometry could replace the more specialized ones now used. As a first step it is necessary to review some aspects of the scattering from small particles and the internal interference arising in the case of larger particles. This opportunity is taken to present a compilation of the scattering factors and the quantities derived from them, that is the dissymmetry and correction factor, in a more precise and convenient form than has appeared previously, because of the use to which they are put in the following sections. The calculations relating to the case of transmittance of solutions containing larger particles are then presented and in the final sections the application of both methods of observation to the determination of the m.w. and size of samples of polystyrene and tobacco mosaic virus is reported. A.

541.18.02

710. Elastic thixotropy. W. F. O. Pollett. Letter in *Research, Lond.*, **3,** 483 (*Oct.*, 1950).

In plasticized polyvinyl chloride at about 190°C tested in a modified Weissenberg rheogoniometer the tangential stress remains nearly constant at constant rate of shear, but the normal stress component rises to a maximum at a total shear of about 100 and then falls off to a limiting value. Measurements of strain recovery immediately after various amounts of shear at constant rate shows that shears up to about 10 are largely elastic; the recovery from larger shears decreases as the shear increases, with an abrupt increase in the rate of decrease at a shear of about 100. The figures are largely independent of the rate of shear. The results suggest a progressive reduction during shear in the number of secondary cross-linkages in the molecular network.

J. G. OLDROYD

541.18.025 : 539.501

711. Thixotropy and electrical behaviour. A. de Waele. Letter in *Nature, Lond.*, **166,** 401 (*Sept.* 2, 1950).

The conductivity and capacity of thixotropic materials is discussed in connection with their rheological behaviour. J. E. CAFFYN

541.182.3 : 538.221

712. On the behaviour of iron oxide aerosols. O. E. Schweckendiek. *Z. Naturforsch.*, **5a,** 397–9 (*July*, 1950) *In German.*

It is shown that the iron oxide particles behave as small magnets when the aerosol is prepared by burning Fe pentacarbonyl in CO. This explains the way in which the aggregates formed during coagulation are in the form of chains. J. M. HOUGH

541.183

713. A method of integrating the Gibbs adsorption isotherm. A. E. Alexander and A. M. Posner. *Nature, Lond.*, **166,** 432–3 (*Sept.* 9, 1950).

When $\pi > 15$ dyne cm^{-1}, the $\pi \sim c$ curve for normal aliphatic alcohols is so curved that the direct integration of the Gibbs adsorption isotherm is inaccurate (π = surface pressure of film, c = concentration of solution). A method of plotting the results is given which enables A_0 and x of the equation $\pi(A - A_0) = xkT$ to be obtained (A = area, A_0 = co-area, each per molecule; x is a measure of the adhesion of the molecules). S. J. GREGG

541.183

714. The adsorption of carbon disulphide vapour flowing through a tube filled with activated charcoal. H. A. Vreedenberg. *Rec. Trav. Chim. Pays-Bas*, **69,** 1233–51 (*Sept.–Oct.*, 1950).

The course of the adsorption of CS_2 vapour from a mixture of air and CS_2, which flows through a long tube with activated charcoal, is calculated as a function of the time and of the place in the tube. For this purpose the analogous theory on the increase of the temperature of a solid in a furnace, through which a hot liquid or gas flows, can be used. A.

541.183 : 541.64

715. The swelling of cross-linked amorphous polymers under strain. L. R. G. TRELOAR. *Trans Faraday Soc.*, **46**, 783–9 (*Sept.*, 1950).

Vulcanized natural rubber in benzene and heptane was investigated. Three types of strain were examined, i.e. simple elongation, 2-dimensional extension and uni-directional compression. The swelling ratios were determined and changes in swelling ratios of up to 50% were observed, the swelling increasing under tensile stresses and falling under compressive stresses. The results were accurately accounted for by the author's extension of the Flory–Rebner statistical theory, using two independent parameters—one the μ-value in the Flory–Huggins equation for the free energy of mixing and the other the degree of cross-linking. It is concluded that for good swelling agents this theory is applicable to a homogeneous strain of the most general type. A.

541.183.5

716. Influence of gas adsorption on polymorphic transformations. H. FORESTIER AND J.-P. KIEHL. *C.R. Acad. Sci., Paris*, **230**, 2288–90 (*June* 26, 1950) *In French.*

The transformation temperatures of powdered SnO_2, Tl, KNO_3 and $AgNO_3$ are found to be lowered by adsorbed gases, the amount of lowering being greater the less the boiling point of the gas.

L. G. CARPENTER

541.183.5

717. The lowest energy of symmetric configurations. S. KRUYER. Letter in *J. Chem. Phys.*, **18**, 1112 (*Aug.*, 1950).

The addition of a diatomic to a linear triatomic molecule presents an exception to the conclusion: the lowest state of a symmetric configuration is determined by the wave functions invariant under the group under which the atomic configuration transforms. Numerical calculations for adsorption of N on Fe show that the lowest energy is given by antisymmetric functions. J. JACOBS

CHEMICAL STRUCTURE 541.4/.6

541.4

718. The transuranics and other newly discovered elements. H. J. EMELÉUS. *Sci. Progr.*, **38**, 609–21 (*Oct.*, 1950).

A review of the discovery, chemistry and production of the transuranics and of Tc, Pm, At and Fr.

541.57

719. Bond localization energy. I. Definition, methods of computation, and relation to bond order. R. D. BROWN. *Aust. J. Sci. Res. A*, **2**, 564–78 (*Dec.*, 1949).

A new quantity—the bond localization energy—which has some advantages in the theoretical discussion of the chemical reactivities of various bonds, is introduced. Its relationship to the activated complex is indicated. It is shown to be expressible in terms of the resonance energies of certain molecules related to the molecule being considered. The various methods available for computing resonance energies by the LCAO method are outlined and some of these are used to derive numerical values for the localization energies of particular bonds. The relationship between bond localization energy and mobile order is investigated, and the significance of the relations thus found is indicated. A.

541.57 : 530.145

720. Quantum-mechanical resonance between identical molecules. H. JEHLE. *J. Chem. Phys.*, **18**, 1150–64 (*Sept.*, 1950).

The process of synapsis of chromosomes in meiosis and the process of self-duplication of genes in mitosis reveal the existence of a highly specific attraction between pairs of large molecules provided they are identical and rigid. The quantum-mechanical behaviour is investigated of a pair of molecules which interact with each other by means of vibrating electric dipole moments which are thermally excited. Because of resonance between equal frequency modes or commensurable modes of vibration, each one of the molecules shows a statistical preference for certain phase relations between these modes (using the language of the correspondence principle). A pair of molecules interacts strongly if it is an identical pair because of these phase preferences. A.

541.64

721. Probable distribution of segments of a polymer around the center of gravity. A. ISIHARA. Note in *J. Phys. Soc. Japan*, **5**, 201 (*May–June*, 1950).

541.64

722. Polymerization under the influence of hydrogen ions. A. E. SIMCHEN. *C.R. Acad. Sci., Paris*, **231**, 282–5 (*July*, 1950) *In French.*

Mathematical analysis of the equation

$$[H]^m\gamma^a/(1-\gamma)^b = K[C]^{(b-a)}$$

leads to an S-like curve for any physical property plotted against *p*H. The *p*H value for the central inflexion point is $(0{\cdot}4343/m)\{(a-b)\ln(a-b)C - \ln K - \ln[(\sqrt{(ab)}-b)^b/(a-\sqrt{(ab)})^a]\}$, while the slopes at the three inflexion points are $(d\gamma_1/dp\mathrm{H}) = (d\gamma_2/dp\mathrm{H}) = 0$, and $(d\gamma_3/dp\mathrm{H}) = 2{\cdot}303m(a+b-2\sqrt{(ab)})/(a-b)^2$. F. LACHMAN

541.64

723. Initiation of the polymerization of acetaldehyde into polyacetaldehyde. M. LETORT AND J. PÉTRY. *C.R. Acad. Sci., Paris*, **231**, 519–21 (*Sept.* 4, 1950) *In French.*

It was shown that paraldehyde, redistilled in pure dry N and depolymerized, yields, when subjected to crystallization, less than 0·5% by weight of polyacetaldehyde. On the contrary, the presence of the "peroxide" oxygen in air increased the experimental yield of polyacetaldehyde to approx. 17% by weight. It seems that peracetic acid is the real initiating agent of the polymerization reaction. F. LACHMAN

541.64 : 541.127

724. Studies in copolymerization. The evaluation of the kinetic coefficients for the system styrene-butyl acrylate. E. J. ARLMAN AND H. W. MELVILLE. *Proc. Roy. Soc. A*, 301–21 (*Oct.* 10, 1950).

The mechanism has been investigated in mixtures

of these monomers using benzoyl peroxide as initiator. The peroxide was decomposed both thermally and photochemically. Experiments on the composition of the polymer as a function of the monomer composition have given reactivity ratios. The kinetics of the copolymerization have been determined and it has been shown that the styrene radicals react with the butyl acrylate radicals more quickly than the mean rate of reaction of styrene to styrene and butyl acrylate to butyl acrylate radicals. The coefficient ϕ defining this increased activity is not in this case constant and rises with increasing styrene content to a value of as much as 150. The initiation mechanism is also complicated in that there is no linear relation between the rate of initiation and monomer composition; instead, the rate drops rapidly when styrene is added to the butyl acrylate. A.

541.64 : 548.5

725. Relationship between the conditions of crystallization of acetaldehyde and its polymerization. M. Letort and J. Pétry. *C.R. Acad. Sci., Paris*, **231**, 545–7 (*Sept.* 11, 1950) *In French.*

It was shown that, for a constant concentration of the initiating agent (most probably the peracetic acid), the duration of crystallization and the number of the crystallization nuclei have a considerable and complex influence on the reaction yield and the molecular weight of polyacetaldehydes formed. F. LACHMAN

541.65 : 539.153.1

Optical rotation and atomic dimension. *See Abstr.* 555

541.651

726. Colour and constitution. I. Basic dyes. M. J. S. Dewar. *J. Chem. Soc.*, 2329–34 (*Sept.*, 1950).

The calculation of light absorption by the molecular-orbital method is discussed, and reasons are given for believing that basic dyes should provide a favourable case for its application. This conjecture has been confirmed by agreement between the calculated and experimental absorption frequencies for a number of basic dyes. A general molecular-orbital theory of such dyes is proposed which leads to a comprehensive set of rules for the effect of structural changes on light absorption. A.

541.68

727. Connection between intrinsic viscosity and molecular weight of nitrocelluloses. A. Münster. *Naturwissenschaften*, **37** (*No.* 16) 375 (1950) *German.*

The equation $[\eta] = K_m P^{\alpha}$, where $[\eta]$ is th intrinsic viscosity, K_m is a constant independent c molecular weight, P is the degree of polymerizatio and α is a constant, which, however, for some systen appears to be dependent on P, has been tested fo solutions of various fractions of nitrocellulose i acetone. For a degree of polymerization up to abou 500, α is approx. 1, but for higher molecular weigh α decreases to about 0·5. A. J. ME

CHEMICAL ANALYSIS 543/545

545.8

728. An electronic image converter and its use i chromatography. Z. V. Harvalik. *Analyt. Chem* **22**, 1149–51 (*Sept.*, 1950).

The converter employs an image tube, Typ CV-147, which converts infra-red into visible ligh The colour-sensitivity of the tube also permits observa tion of ultraviolet light. The colour range of th device is 300 to 1 400 millimicrons and its magnifica tion power is 2·5×. The addition of this device t chromatographic techniques necessitates a new d broader definition of the term "ultrachromatography and the introduction of the terms "infra-" an "fluorochromatography."

545.8

729. Ion exchange resins in chromatography C. W. Davies. *Research, Lond.*, **3**, 447–52 (*Oct.*, 1950

The properties of ion exchange resins are brief considered. Besides the usual classification as catio and anion exchangers, a classification into stron electrolyte exchangers (I) and weak electrolyt exchangers (II) would be helpful. In (II) the exchang capacity depends greatly on *p*H and the rate o exchange is slow if it involves a change of *p*H. Th "break through" and the "elution" methods o procedure together with their application to th separation of (i) isotopes (e.g. Li^6 and Li^7), (ii) wea electrolytes, (iii) strong electrolytes (e.g. rare earths are considered. "Chromatography" is now applie to any process in which a separation is brought abou by the relative motion of two phases. S. J. GREG

CRYSTALLOGRAPHY 548

548.0 : 535.343.2

730. Theory of color centers in ionic crystals. II. T. Inui and Y. Uemura. *Progr. Theor. Phys.*, **5**, 395–404 (*May–June*, 1950).

See Abstr. 8318 (1950). The temperature-dependence of *F*-absorption bands is theoretically studied. It is concluded that the main cause of the shift of the absorption peak is the thermal expansion of the lattice. The temperature dependence of the band half-breadth is calculated using the Einstein model of lattice vibration. Quantitative results are in good agreement with Mollwo's experiments over wide range of temperature for various kinds o alkali halides. A

548.0 : 535.343.

731. Nature of trapped hole colour centres in th alkali halides. E. Burstein and J. J. Oberly. Lette in *Phys. Rev.*, **79**, 903–4 (*Sept.* 1, 1950).

Various types of electron and positive hole trappin centres in alkali halides are discussed. Absorptio spectra in the u.v. are given for X-rayed KCl, KB

and KI. It is suggested that *V* centres are due to formation of diatomic halogen molecules rather than to single holes trapped at single positive ion vacancies.

G. F. J. GARLICK

548.0 : 535.343.2–15

The infra-red spectra for single crystals of ammonium nitrate and thallous nitrate in polarized radiation. *See Abstr.* 196

548.0 : 535.343.2–15

Infra-red spectra for ammonium nitrate, thallous nitrate and plumbous nitrate at −160° and 25°C. *See Abstr.* 197

548.0 : 535.371

732. Luminescence of colour centres in alkali halides. C. C. CLICK. Letter in *Phys. Rev.*, **79**, 894–6 (*Sept.* 1, 1950).

Luminescence emission from colour centres in LiF and NaCl is studied. Irradiation in *F* bands of either halide produces no luminescence even at liquid He temperatures. Emission occurs from *M* centres in LiF at room temperature and below, and spectra are given.

G. F. J. GARLICK

548.0 : 535.375.5

Raman spectra of the second order in crystals. *See Abstr.* 223

548.0 : 535.41

733. The structure of labradorite and the origin of its iridescence. C. V. RAMAN AND A. JAYARAMAN. *Proc. Indian Acad. Sci. A*, **32**, 1–16 (*July*, 1950).

The iridescence is caused by crystallites of potash feldspar or lamellae of orthoclase in the labradorite. Theoretical consequences of this segregation have been confirmed with a number of specimens: (*a*) multiply twinned labradorite shows characteristic reflections related to each other by the twinning law, visible as banding in one or both reflections; (*b*) light reflected transversely to the incident beam is completely polarized; (*c*) intensity of reflected light is independent of setting of reflecting layers in their own plane; (*d*) for very small crystallites the reflected light shows an effect similar to Tyndall diffusion; (*e*) the angular spread of reflected light is greatest for blue iridescence and less for other colours. Effects on illuminating with polarized light are also described and explained.

C. TURNER

548.0 : 535.43

Thermal scattering of light in crystals. I. Quartz. *See Abstr.* 238

548.0 : 535.66

734. The discoloration of natural blue and violet rocksalt crystals. N. ADLER. *Acta Phys. Austriaca*, **4** (*No.* 1) 71–80 (1950) *In German.*

The discoloration by warming was investigated on specimens of blue rocksalt from Stassfurt and violet rocksalt from the Grimberg mine by measuring the absorption spectra and by ultra-microscopical methods. The blue salt changes to violet and loses all colour after 3 hours at 300°C; the violet salt does not change in colour and is discoloured after two hours at 200°C. The colour of the Tyndall cone on different specimens does not tie up with the changes in absorption spectrum, and it is assumed that the blue colour is due to colloidal centres and the yellow to centres of a different type, as for example the *R*-centres of Seitz [Abstr. 2317 (1947)].

W. F. BERG

548.0 : 537.311.32 : 541.135.4

735. On the theory of ionic conductivity in crystals. Y. HAVEN. *Rec. Trav. Chim. Pays-Bas*, **69**, 1259–74 (*Sept.–Oct.*, 1950).

The experimental $\log x$ *v.* $1/T$ curves usually consist of two straight parts with different slopes. This shape can be explained by several mechanisms. For the conductivity of mixed crystals, where the solute introduces additional vacancies, a formula was derived which gives the conductivity as a function of the concentration of the solute and of the temperature. This formula also explains the kink in the conductivity curve. A method of choosing between the explanations for the kink in the conductivity curve in a given case was found, based on an analysis of the transition region between the two straight parts of the curves.

A.

548.0 : 537.312.5

736. Polaron states in ionic crystals. H. B. CALLEN. Letter in *Phys. Rev.*, **79**, 533–4 (*Aug.* 1, 1950).

The possibility of detecting polaron states (electron in conduction band + surrounding polarization) in crystals by the shift in optical absorption frequency with temperature is discussed. Present experimental methods do not allow a quantitative study of the effect.

G. F. J. GARLICK

548.0 : 539.373

737. Prismatic dislocations and prismatic punching in crystals. F. SEITZ. Letter in *Phys. Rev.*, **79**, 723–4 (*Aug.* 15, 1950).

The punching of square cross-section prisms in thallous halides on indentation [Abstr. 5029 (1949)] where the load is applied in the (100) direction (resulting in one prism), (110) (2 prisms), (111) (3 prisms) is called prismatic indentation. It is shown how prismatic dislocations may be generated and interact, to satisfy the observations, dislocation rings being generated so that their contours coincide with the cross-section of the prismatical punchings, with the Burgers vector along the prism axis, and, if there is no diffusion, their movement is constrained to the prism surface. The situation is studied geometrically. One consequence is the possible production of an unlimited number of prismatic dislocations by the wrapping around the surface of the prism of a dislocation spiral generated in one of the faces.

A. J. KENNEDY

548.0 : 539.373

738. Restriction of prismatic punching to a limited class of crystals. F. R. N. NABARRO. Letter in *Phys. Rev.*, **79**, 894 (*Sept.* 1, 1950).

548.5

739. The formation of microcrystals on crystal surfaces on treatment with Po–α-rays. L. WIENINGER AND N. ADLER. *Acta Phys. Austriaca*, **4** (*No.* 1) 81–4 (1950) *In German.*

$NaNO_3$ microcrystals are formed when NaCl crystals in air are irradiated with Po–α-rays. The α-rays cause the formation of O_3 and NO_2. A thin water layer on the surface of the NaCl crystals provides the water needed to form $NaNO_3$. Anisotropic KNO_3 formed on KCl is mixed with a few

isotropic crystals (m.p. 500°C). Both forms are recrystallized by breathing on the crystals, but the anisotropic microcrystals change their orientation. After 4 months in the dark the anisotropic crystals had changed from rectangular to triangular forms, but the isotropic crystals were unchanged. KBr gives isotropic crystals only; these partly change to anisotropic crystals after several months' exposure to the air. Similar reactions with fluorites and calcite are being investigated. C. TURNER

548.5

740. On the energy thresholds in crystal growth. I. N. STRANSKI. *Naturwissenschaften*, **37** (*No.* 13) 289–96 (1950) *In German.*

A survey of theories of crystal growth, with many references. Crystal growth depends on 3-, 2- and 1-dimensional nucleation. Discrepancies between theoretical and observed growth rates at low supersaturations are explained by the occurrence of dislocations and uneven surfaces, allowing growth to proceed by linear nucleation alone, or making nucleation unnecessary. The alteration of a growth form of a crystal into the equilibrium form by annealing is facilitated by the presence of re-entrant edges at which linear nucleation can occur, molecules being transported through a surface absorption layer. Some abnormal evaporation phenomena are discussed. J. A. FRANKS

548.5

741. On the formation of dislocations from vacancies. F. SEITZ. Letter in *Phys. Rev.*, **79,** 890–1 (*Sept.* 1, 1950).

The ion vacancies in crystals grown from the melt may migrate to the surface, join dislocations or condense on particular lattice planes. It is proposed that the practical lower limit of the number of dislocations found in crystals grown from the melt is determined by the condensation of vacancies into plates to form general dislocation rings. These rings have the characteristics required to explain properties of crystals, depending on the existence of dislocations. J. A. FRANKS

548.51

742. Formation of crystal nuclei in liquid metals. D. TURNBULL. *J. Appl. Phys.*, **21,** 1022–8 (*Oct.*, 1950).

The known facts about nucleation phenomena in liquid metals are interpreted satisfactorily on the basis of the critical size and interfacial energy concepts. In large continuous masses nucleation is almost always catalyzed by extraneous interfaces. However, in very small droplets the probability that a catalytic inclusion is present is so much less that their minimum nucleation frequencies are reproducible and form a consistent set of values. Interfacial energies, σ, between crystal nuclei and the corresponding liquids have been calculated from nucleation frequencies of small droplets on the basis of the theory of homogeneous nucleation. Energies of interfaces, σ_g, one atom thick and containing N atoms were calculated from the σ's. The ratio of σ_g to the gram atomic heat of fusion, ΔH_f, was approximately 0·45 for most metals but $\sim$0·32 for H_2O, Bi, Sb and Ge. The effect of relative complexity of crystal structure upon the supercooling behaviour of pure metals apparently is a reflection of its effect upon ΔH_f. A.

548.538

743. Oriented crystalline deposits on active substrates. A. NEUHAUS AND W. NOLL. *Naturwissenschaften*, **37** (*No.* 16) 374–5 (1950). *In German*

It is suggested that preferred orientation of crystalline films deposited on a substrate is less evident the harder the substrate. Heating the substrate, however, increases the tendency to orientation. The results of experiments in which KBr, KCl, NaBr, NaCl are deposited on feldspar are briefly described. M. R. HOPKINS

548.538

744. Some observations on the epitaxy of sodium chloride on silver. G. W. JOHNSON. *J. Appl. Phys.*, **21,** 1057–62 (*Oct.*, 1950).

An experimental study was made of the orienting effects of Ag on NaCl crystallized from solution. Pronounced epitaxy was observed in the following cases: (i) on oriented films of Ag with (100) and also with (111) planes parallel to the surface; and (ii) on polycrystalline high purity Ag sheet. A.

548.538 : 538.22

745. Oriented crystals: their growth and their effects on magnetic properties. W. MORRILL. *Gen. Elect. Rev.*, **53,** 16–21 (*Aug.*, 1950).

A general account of magnetic anisotropy and of the production of single crystals or oriented polycrystalline specimens of magnetic materials. Factors affecting recrystallization and orientation are described. A. E. DE BARR

548.55 : 539.211

746. Single crystal copper surfaces. T. N. RHODIN, JR. *J. Appl. Phys.*, **21,** 971–3 (*Oct.*, 1950).

Some surface structure characteristics of a metal single crystal are considered and the conclusions are applied to the preparation of single crystal plates of Cu. A successful preparation is described as well as suitable methods for evaluating the effectiveness of the preparation. Using physical microadsorption isotherms of N at 78·1°K, electron diffraction and X-ray diffraction methods, the conclusion is tentatively asserted that the surfaces are essentially planar on a molecular scale, and that the surface atoms are arranged in an approximately undistorted lattice. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

747. Anharmonicity of the lattice oscillations in the alkali halide crystals. K. S. KRISHNAN. Letter in *Nature, Lond.*, **166,** 571 (*Sept.* 30, 1950).

548.7 : 536.7

748. A method of approximation for co-operative phenomena. R. KIKUCHI. Letter in *Phys. Rev.*, **79,** 718 (*Aug.* 15, 1950).

This gives the entropy of an order-disorder system

aving an assigned energy. By suitable choice of ariables, the method gives the Bethe–Takagi approxiation in one case [*Proc. Roy. Soc. A*, **150**, 552–75 *July* 1, 1935) and Abstr. 1116 (1941)] and the ariation method of Kramers and Wannier [Abstr. 412 (1941)] in another. Entropy, transition temperare and specific heat are given for a 2-dimensional quare net, a simple cubic lattice, and a face-centred ubic lattice. C. TURNER

548.7 : 539.152.2

Nuclear electric quadrupole interactions in crystals. *ee Abstr.* 548

548.7 : 539.264 : 669

49. Lattice parameters of binary nickel–cobalt lloys. A. TAYLOR. *J. Inst. Met.*, **77**, 585–94 (*Aug.*, 950).

548.73

50. Determination of the parameters of beryl by ie method of partial projections. N. V. BELOV AND . G. MATVEEVA. *Dokl. Akad. Nauk, SSSR*, 73 *No.* 2) 299–302 (1950) *In Russian.*

The method [Abstr. 277 (1946)] is applied to the ortion of the cell between $\pm \frac{1}{4} c$. The structure of ragg and West [*Proc. Roy. Soc. A*, **111**, 691 (1926)] confirmed, with a revision of the parameters of the atom in the general position from 0·48, 0·15, 0·15 0·503, 0·143, 0·138. A. J. C. WILSON

548.735.44 : 518.5

51. A mechanical X-ray structure-factor calculating achine. V. VAND. *J. Sci. Instrum.*, **27**, 257–61 *Oct.*, 1950).

A mechanical machine, of a tide predictor type, apable of carrying out X-ray crystallographic tructure-factor calculations for up to 24 atoms is escribed. It has facilities for refining the atomic o-ordinates by the method of steepest descents. ufficient power is available to drive a recording echanism. It calculates at a speed of about 8 tructure factors per minute. A.

548.736.1

752. Lattice constant of grey tin. L. D. BROWNLEE. Letter in *Nature, Lond.*, **166**, 482 (*Sept.* 16, 1950).

The lattice spacing in absolute angstrom units is 6·4912 ± 0·005 Å. The X-ray density, calculated from the formula $\rho = 1{\cdot}66020\Sigma A/V$, is $\rho = 5{\cdot}765$ g/cm.^{3} A.

548.736.1

753. Allotropy of beryllium. S. S. SIDHU AND C. O. HENRY. *J. Appl. Phys.*, **21**, 1036–7 (*Oct.*, 1950).

This has been confirmed by employing different alloying properties of allotropic forms of metallic elements. Alloys of Be and Au, studied by X-ray diffraction methods, showed that the limit of solubility of Au in Be is between 2 and 3 atomic percent, and practically all of it is dissolved in the β-form. The lattice parameters of the two forms observed here are: $a_0 = 2{\cdot}286$ Å, $C_0 = 3{\cdot}588$ Å and $C_0/a_0 = 1{\cdot}570$ for the α-form, and $a_0 = 6{\cdot}93$ Å, $C_0 = 11{\cdot}35$ Å, and $C_0/a_0 = 1{\cdot}638$ for the β-form. The volume of the unit cell of the β-form is about 29 times that of the α-form. A.

548.736.3

754. Structure of the disilicide of cobalt. F. BERTAUT AND P. BLUM. *C.R. Acad. Sci., Paris*, **231**, 626–8 (*Sept.* 25, 1950) *In French.*

The existence of a Si-rich phase $CoSi_2$ (CaF_2 structure, $a = 5{\cdot}365$ Å) is established; it is suggested that previous workers have mistaken it for a solid solution of Co in Si. Any primary solubility of Co in Si is insufficient to change the lattice parameter of Si measurably. A. J. C. WILSON

548.736.4

755. Potassium wolfram bronze. E. A. NIKITINA AND A. S. KOKURINA. *Zh. Obshch. Khim.*, **20**, 1380–3 (1950) *In Russian.*

Tetragonal, $a = 4{\cdot}67$, $c = 6{\cdot}81$ Å(?), formula $K_2O.\ 4WO_3$. A. J. C. WILSON

GEOPHYSICS 55

550.341.4

56. Macroseismic methods of focal depth determination. V. INGLADA GARCIA-SERRANO. *Rev. Geofis.*, **9**, 123–46 (*April–June*, 1950) *In Spanish.*

A critical survey of the macroseismic methods of calculation of the focal depth of earthquakes is made, and, as a consequence, a modification of Janosi's, frequently used till now, is proposed. It consists in employing the simultaneous equations with 3 unknowns, resulting from the application of the Kövesligethy and Cancani formulae, and solving it through the method of square minimums without any previous elimination of unknowns, making computations with different depth values. A.

550.38

57. The main geomagnetic field. S. K. RUNCORN. *Sci. Progr.*, **38**, 668–77 (*Oct.*, 1950).

A survey of new experimental and theoretical approaches to the problems of origin and secular variation.

ATMOSPHERE . METEOROLOGY 551.5

551.508 : 621.317.39

758. A direct indicating anemometer. L. RAAB. *Ark. Geofys.*, **1**, *Paper* 5, 117–21 (1950).

A series RC circuit is arranged for one of the capacitors to be short-circuited by an anemometer shaft; thus the average voltage across the capacitor is $\propto$ wind speed. Alternative cases are investigated mathematically and voltage expressions derived for each case. Either an indicating or a recording instrument may be used; alternatively a Wheatstone bridge and servo system may be used if the voltage supply

is unstable. The final circuit includes a 2-stage cathode-follower amplifier, a.c. mains-operated.

E. H. W. BANNER (R)

551.508.5 : 621.317.39

759. The development of electrical anemometers. G. E. W. HARTLEY. *Instn Elect. Engrs, Paper* 1063, 8 *pp.* [*Early proof issue.*]

Methods of calibration and standardization are discussed in relation to the accuracy and speed of response of standard instruments, and some further models which were made for special investigations, or are still being developed, are described. For general use in the Meteorological Office, the most suitable combination of instruments is a cup anemometer of the generator type with an autographic recorder consisting of some form of recording voltmeter and a remote-recording wind vane connected by a self-synchronous a.c. transmission system to a recorder which is capable of being operated by a small torque. The cup anemometer will record the speed of the wind and the wind vane will record its direction. A.

551.508.5 : 621.317.39

760. Wind- and gust-measuring instruments developed for a wind-power survey. H. H. ROSENBROCK AND J. R. TAGG. *Instn Elect. Engrs, Paper* 1065, 10 *pp.* [*Early proof issue.*]

A description is given of two recorders and an anemometer for measuring gusts, which were developed for use in a survey of the available wind-power in Great Britain. The essential feature of the recorders is that they operate unattended for a period of one week. The first instrument is a photographic recorder which shows, at intervals of ½ hr, the wind direction and the run of wind past four standard cup-contact anemometers. The second instrument records a mark for each two miles of wind, and will make up to four simultaneous records. The anemometer for measuring gusts uses a perforated aluminium sphere as the detecting element and a mechano-electronic transducer valve to convert the mechanical response to an electrical output. It is compensated for changes of temperature and for the static effects of atmospheric pressure. When used with an amplifier-driven recording voltmeter, the response of the prototype instrument to an instantaneous change of wind speed from 65 to 85 m.p.h. was completed in about 0·07 sec. Modified forms of the instrument are described which measure, respectively, the horizontal components of the wind in two directions at right angles and the vertical component. A.

551.510.41

761. The tritium content of the atmosphere. V. FALTINGS AND P. HARTECK. *Z. Naturforsch.*, **5a**, 438–9 (*Aug.*, 1950) *In German.*

The free hydrogen of a known volume of air was burnt to form water, and the tritium content found from the beta-activity of the water. There is about one tritium atom in 10 cm^3 of air. N. CORCORAN

551.521 : 535.345

762. On the spectral energy distribution in the image on the ground glass screen of a sphere illuminated by the sun, the sky and reflex light. M. NAGEL. *Optik*, 7 (*No.* 1) 1–12 (1950) *In German.*

Known spectral transmission data are given graphically for various optical glasses, also ne results for some commercial lenses. Transmission i the near u.v. varies with the complexity of the le and affects the warmth or coldness to be expected i colour reproduction. Colour differences arisin between axial and oblique pencils are briefly examine For a normal objective the transmission at 3 500 Å 25% of that at 5 750 Å, at 3 750 Å 65%, at 4 000 Å 90% at 4 250 Å 94%, at 5 000 Å 97%. Hence a final ca culation of the spectral distribution in the imag shown graphically for different ratios of sun to sk light. In general the image appears to contain mor blue than was previously thought; and contrary t the usual view, standard photographic light source are thus shown to be not blue enough.

S. T. HENDERSO

551.557 : 621.396.9

763. Meteoric echo study of upper atmosphere winds L. A. MANNING, O. G. VILLARD, JR. AND A. M PETERSON. *Proc. Inst. Radio Engrs*, **38**, 877–83 (*Aug* 1950).

A method is developed for measuring the velocit of winds in the 90 to 110 km height region of th upper atmosphere. From the Doppler frequenc shift imparted to a continuous-wave reflection fro a meteoric ionization column, a measure of the win drift of the trail is found. Statistical analysis enable average wind velocities to be measured to withi perhaps 20%, and direction to 20°, in a period of or 2 hr. Observations made during the early mornin hours in the summer of 1949 show typical averag wind velocities to be 125 km/h with motions fro south-southwest and north the most common. O some occasions, evidence of a non-uniform win structure is found. A

551.593.9 : 535.338.4 : 539.13

Anomalous molecular rotation and upper-atmospher temperature measurements. *See Abstr.* 532

551.594.1

764. Continued measurements of the variatio characteristics of the density of small ions. H NORINDER AND R. SIKSNA. *Ark. Geofys.*, **1**, *Paper* 10 *pp.* (1950).

Results of measurements of the diurnal variation i density of small ions made in the region of Uppsal during 1949 are given. Some generalizations of th observations, e.g. the ion density is greater in summe than in winter, the effect of wind direction an humidity on density, are indicated. R. DAVI

551.594.22 : 778.3

765. High-efficiency apparatus for lightning chrono photography. D. J. MALAN. *Rev. Opt.* (*Théor Instrum.*) **29**, 513–23 (*Oct*, 1950) *In French.*

In studying the correlation between the optica and the electrical effects of lightning strokes, it ha been found necessary to design a new type of camer combining the respective advantages of differen types of previous cameras, such as drum recordin and ease of film-changing. While the film remain stationary, the optical system is mounted in a rotatin drum. Besides a reflecting prism and an objective, Wollaston prism mounted between these is given a epicyclic rotation at half the speed of rotation of th drum. This counteracts the rotation of the imag

round the reflected optical axis. A few modifications make the apparatus suitable for high-speed recording of oscillograms of irregularly occurring transients. A.

551.594.6 : 621.396.812.3

766. Some random fading records with short-wave signals. P. M. Das and S. R. Khastgir. *Indian J. Phys.*, **24**, 277–80 (*July*, 1950).

Some random fading patterns recorded at Dacca with 4 840 kc/s signals from Calcutta are shown and analysed. Rayleigh's formula for random fading from the various diffracting centres in the ionosphere was not found to agree with the observed signal variations. It is likely that the discrepancy is due to the two sets of waves reaching the receiver after single reflection from the *E*- and *F*-layers or after single and double reflections from the same *F*-layer. A.

551.594.6 : 538.566.2

767. A study of the horizontal irregularities of the ionosphere. B. H. Briggs and G. J. Phillips. *Proc. Phys. Soc., Lond. B*, **63**, 907–23 (*Nov.*, 1950).

The theory of the diffraction by a random screen developed by Booker, Ratcliffe and Shinn is presented in a convenient form for practical application in ionospheric experiments. It is shown that measurements of the correlation of the fading of the reflected wave observed at spaced receiving points can be used to find the extent of the angular spreading of the downcoming wave. Histograms are given to show the frequency of occurrence of different degrees of angular spreading observed during a series of experiments using pulse transmissions at vertical incidence. For a frequency of 2·4 Mc/s it is most common to find that the downcoming wave has an angular spread such that the amplitude falls to half value at an angle of 5° for regions *E* and *F*. For region *F* observed on 4·8 Mc/s, the corresponding value is 2·5°. There is no evidence for any pronounced seasonal or diurnal variations. A.

BIOLOGY 57/59

578.088.5 : 537.531

768. On a mathematical theory of the reaction of cells to X-ray irradiation E. Pinney. *Bull. Math. Biophys.*, **12**, 199–206 (*Sept.*, 1950).

To describe the variation of concentration of certain substances in cells subjected to X-rays for a finite length of time, R. M. Sievert [*Acta Radiol.*, **22**, 237–51 (1941)] has given an equation of mixed differences involving time-lag and having discontinuous coefficients. In the present paper Laplace transform methods are applied to solve this equation in terms of a series valid for all values of time. In particular, the conditions given by J. T. van der Werff [*N. Arch. Wisk.*, **21**, 197–211 (1943)] that the concentration approaches a constant value are confirmed; otherwise steady oscillations in concentration may be expected, or oscillations appear whose amplitude steadily increases until the cell is destroyed or the assumed mathematical model otherwise fails to apply. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.84

769. The resolution of double stars. D. A. Fiorentini. *Atti. Fond. "Giorgio Ronchi,"* **5**, 195–9 (*Aug.*, 1950).

The visual resolving power of an observer has been measured, using two monochromatic stars set at a variable distance apart. If the visual angle is kept constant pairs of stars having the same intrinsic intensity but different distance will transmit to the retina different amounts of energy. This energy W and the distance of the stars from the eye, as well as their mutual separation d have been systematically changed, and experimental curves have thus been drawn plotting the energy W in terms of d. Within experimental conditions, the larger is d the higher is the value of W necessary to maintain a constant resolving power. A.

612.844.1

770. The crystalline lens and its reaction in different subjects treated by various mydriatics. J. Marandon. *Rev. Opt. (Théor. Instrum.)* **29**, 524–42 (*Oct.*, 1950) *In French.*

A short history of various theories of accommodation is followed by an account of several experimental arrangements designed to measure the change in curvature of the lens on applying a mydriatic. The one finally adopted is based on measuring the size of, and the distance between, the images of two lamps in a vertical plane, reflected from the anterior surface of the lens, in terms of these quantities as obtained from the corneal reflections. A scale is obtained for each subject by varying the accommodation in steps of 0·5 *D* up to 10 *D* whenever possible. The effect of different mydriatics is measured on this scale, a table giving the sizes of the Purkinje images and the anterior radii of curvature of the lens for different subjects and drugs. The method is photographic, but no experimental photographs are shown. Diagrams and a photograph of the apparatus are given. R. A. Weale

614.8 : 537.591.08

Calibrated X-ray film badge dosimeter. *See Abstr.* 361

615.849 : 539.16.08 : 537.542

771. Dosimetry of ionizing particles. G. Failla and H. H. Rossi. *Amer. J. Roentgenol. Radium Ther.*, **64**, 489–91 (*Sept.*, 1950).

The problem is twofold: (1) the establishment of a unit, and (2) the accurate measurement in terms of it. No international unit exists at present, but the "rep" (H. M. Parker) involves fundamentals of energy absorption in tissue applicable to ionizing radiations. Dosimetry is simple for charged particles producing primary ionization only, where a measuring chamber,

filled with tissue-equivalent gas, and whose wall-absorption is known, will satisfy Bragg's law. When appreciable secondary emission is produced, the measuring chamber walls must be tissue-equivalent also; it can then be shown that energy imparted per gram is independent of particle range or chamber dimensions. A mixture of water, gelatine and sucrose provides a tissue-equivalent formula; this will harden on addition of 0·5% formaldehyde, and retain its properties if hermetically sealed. Humidity is high, but polished polystyrene is sufficient insulation. As it is absorbed in the walls, GO_2 cannot be used as a constituent of the filling gas, which must be a mixture of CH_4, H_2, O_2 and N_2. D. V. MABBS

TECHNICAL MATERIALS 66/67

666.1.056.5

772. A nickel-chromium-iron alloy for sealing to glass. J. E. STANWORTH. *J. Sci. Instrum.*, **27**, 282–4 (*Oct.*, 1950).

The development is described of a Ni–Cr–Fe alloy containing 47% Ni and 5% Cr and matching ordinary Pb glass as used in the manufacture of electrical lamps and valves. Stresses in seals made with these materials are low at all temperatures, even though there is a 60° difference between the alloy Curie temperature (about 340°) and the glass transformation temperature (about 400°). A.

669 : 541.123.2

773. The constitution of uranium–molybdenum alloys. P. C. L. PFEIL. *J. Inst. Met.*, **77**, 553–70 (*Aug.*, 1950).

669 : 541.123.2 : 539.264

774. The uranium–iron system. J. D. GROGAN. **An X-ray examination of uranium–iron alloys.** C. J. B. CLEWS. *J. Inst. Met.*, **77**, 571–80 (*Aug.*, 1950).

PHOTOGRAPHY 77

771.531.17 : 778.3 : 539.388.8

775. Temperature coefficient of swelling and development in thick emulsions for nuclear research. G. W. W. STEVENS. *Photogr. J., B*, **90**, 129 (*Sept.–Oct.*, 1950).

Comparisons of the rate of swelling and development of a nuclear track emulsion at 4° and 18°C., respectively, show that the development rate is more than 4 times as great at the higher temperature, while the swelling rate is only 1½ times as great. The method of pre-soaking the emulsion in cold developer should thus favour swelling without greatly increasing the degree of development. A.

778.37 : 537.228.4 : 621.383.6 : 621.396.615.17

776. A Kerr cell camera and flash illumination unit for ballistic photography. H. F. QUINN, W. B. MCKAY AND O. J. BOURQUE. *J. Appl. Phys.*, **21**, 995–1001 (*Oct.*, 1950).

An experimental model of a combination designed specifically for the photography of projectiles under conditions of strong ambient illumination is described. Specific cases wherein such conditions are found are considered and the applicability of the Kerr cell as a secondary protecting shutter is described. A description is given of a pulse forming network—pulse transformer circuit designed to apply an operating voltage pulse to a Kerr cell of 36 kV amplitude and 1·9 μsec duration. Limitations inherent in the present equipment are considered together with proposals for overcoming these defects in future models. Typical results are presented, including (*a*) a picture taken with the unit showing a 20 mm shot at the time of emergence from the muzzle of a gun, and (*b*) a picture of a 37 mm shot taken shortly after penetration of a metal target plate. A.

778.33 : 537.531.8

777. Electron-microradiography of electrodeposited metals. R. WEIL AND H. J. READ. Letter in *J. Appl. Phys.*, **21**, 1068 (*Oct.*, 1950).

778.3 : 539.17 : 537.312.5

778. Photo-electric measurements of the density of tracks in nuclear emulsions. S. VON FRIESEN AND K. KRISTIANSSON. Letter in *Nature, Lond.*, **166**, 686 (*Oct.* 21, 1950).

778.37 : 551.594.22

High efficiency apparatus for lightning chronophotography. *See Abstr.* 765